Evaluation of an Afforestation/Reforestation Clean Development Mechanism Project Involving Small-scale Farmers in Paraguay

Evaluation of an Afforestation/Reforestation Clean Development Mechanism Project Involving Small-scale Farmers in Paraguay

January 2014

Eiji MATSUBARA

Evaluation of an Afforestation/Reforestation Clean Development Mechanism Project Involving Small-scale Farmers in Paraguay

A Dissertation Submitted to
the Graduate School of Life and Environmental Sciences,
the University of Tsukuba
in Partial Fulfillment of the Requirements
for the Degree of Doctor of Environmental Studies
(Doctoral Program in Sustainable Environmental Studies)

Eiji MATSUBARA

Contents

Acronyms and abbreviations

AF	Agroforestry
A/R CDM	Afforestation and reforestation project activities under the Clean Development Mechanism
A/R-WG	Afforestation and Reforestation Working Group
BCF	BioCarbon Fund
BPP	Beneficiary pays principle
CDM	Clean Development Mechanism
CDM EB	CDM Executive Board
CER	Certified emission reductions
CMP	Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol
COP	Conference of the Parties
CSR	Corporate social responsibility
DBH	Diameter at breast height
DNA	Designated national authority
DOE	Designated operational entity
ERPA	Emission reductions purchase agreement
EU ETS	European Union Emissions Trading System
FAO	Food and Agriculture Organization
GHG	Greenhouse gas
GIS	Geographic information system
GPS	Global positioning system
Gt	Giga tonnes (one billion tonnes)
INDERT	Instituto Nacional de Desarrollo Rural de la Tierra (National Institute of Rural Development of Land)
INFONA	Instituto Forestal Nacional (National Institute of Forestry)
IPCC	Intergovernmental Panel on Climate Change
IPCC-GPG-LULUCF	IPCC good practice guidance for LULUCF
JIRCAS	Japan International Research Center for Agricultural Sciences
KP	Kyoto Protocol
lCER	Long-term CER
LACs	Latin America and Caribbean Countries
LoA	Letter of approval
LULUCF	Land use, land-use change and forestry
MAG	Ministerio de Agricultura y Ganadería (Ministry of Agriculture and Livestock)
MIC	Micro crédito (micro credit)
MIG	Micro proyecto grupal (micro project of farmer group)
NGO	Non-governmental organization
ODA	Official development assistance
PDD	Project design documents
QC/QA	Quality control and quality assurance
SEAM	Secretaría del Ambiente (Secretariat of Environment)
SSF	Small-scale farmer
SV	Stem volume
tCER	Temporary CER
USD	United States dollar
UN	United Nations
UNA	Universidad Nacional de Asunción (National University of Asunción)
UNFCCC	United Nations Framework Convention on Climate Change
WB	World Bank

Terms and definitions

Actual net GHG removals by sinks	The sum of the verifiable changes in carbon stocks in the carbon pools within a project boundary that are attributable to an A/R CDM project activity, as applicable, minus any increase in anthropogenic GHG emissions by sources (measured in carbon dioxide equivalents) within the project boundary that is caused by the implementation of the A/R CDM project activity.
Additionality	For an A/R CDM project activity, the effect of the A/R CDM project activity to increase actual net GHG removals by sinks above the sum of the changes in carbon stocks in the carbon pools within the project boundary that would have occurred in the absence of the A/R CDM project activity.
Afforestation	The direct human-induced conversion of land that has not been forested for a period of at least 50 years to forested land through planting, seeding and/or human-induced promotion of natural seed sources.
Annex I Party	A Party that is included in Annex I to the Convention or a Party that has made a notification under Article 4, paragraph 2(g) of the Convention.
Baseline net GHG removals by sinks	The sum of the changes in carbon stocks in the carbon pools within the project boundary that would have occurred in the absence of the A/R CDM project activity.
Beneficiary pays principle*	Principle based on the idea that the most efficient allocation of resources occurs when consumers pay the full cost of the goods that they consume. In the A/R CDM project in Paraguay, beneficiary farmers' payment for a part of cost of goods and services provided by the project was regarded as a payment from the beneficiary pays principle. The beneficiary farmers were assumed not necessary to pay full cost because forestation had external positive effect.
BioCarbon Fund*	Housed within the Carbon Finance Unit of the World Bank, the BioCarbon Fund is a public-private sector initiative mobilizing financing to help develop projects that sequester or conserve carbon in forest and agro-ecosystems.(BCF 2013)
CDM Executive Board	The Executive Board of the CDM as defined in Article 12 of the Kyoto Protocol. The function of the Board, whose members are elected by the CMP, is to supervise the CDM in accordance with paragraph 5 of the annex to decision 3/CMP.1.
Certified emission reductions	A unit issued for emission reductions from CDM project activities in accordance with the CDM rules and requirements, which is equal to one metric tonne of CO_2 equivalent, calculated using global warming potentials defined by decision 2/CP.3.
Designated national authority	The body granted responsibility by a Party, among other things and where applicable, to issue a letter of approval with respect to CDM project activities on behalf of that Party, in accordance with the CDM rules and requirements.
Designated operational entity	An entity designated by the CMP, based on a recommendation by the CDM EB, as qualified to validate proposed CDM project activities, as well as verify and certify reductions in anthropogenic emissions by sources of GHG and net anthropogenic GHG removals by sinks.

Forestry carbon project*	A project planned or implemented for acquiring human induced carbon credit from forestry sector including afforestation, reforestation, regeneration, and REDD+ (reducing emissions from deforestation and forest degradation; and conservation, sustainable forest management of forest and enhancement of forest carbon stocks).
Forestry CER*	General term of CER issued for A/R CDM project including long-term CER and temporary CER.
IPCC good practice guidance for LULUCF*	IPCC-GPG-LULUCF provides supplementary methods and good practice guidance for estimating, measuring, monitoring and reporting on carbon stock changes and greenhouse gas emissions from land use, land-use change and forestry activities. (IPCC 2003)
Large-scale A/R CDM project	An afforestation or reforestation project where the average projected net anthropogenic GHG removals by sinks for each verification period exceed 16,000 tCO_2 /year.
Leakage	For an A/R CDM project activity, the increase in GHG emissions by sources or decrease in carbon stock in carbon pools which occurs outside the boundary of an A/R CDM project activity, as applicable, which is measurable and attributable to the A/R CDM project activity.
Long-term CER	A unit issued pursuant to Article 12 of the Kyoto Protocol for net anthropogenic GHG removals by sinks from an A/R CDM project activity, which expires at the end of the crediting period of the A/R CDM project activity for which it was issued. It is equal to one metric tonne of CO_2 equivalent.
Middle-scale farmer*	A farmer who owns 20 to 1,000 ha of land in Paraguay are tentatively defined as a middle-scale farmer in this paper.
Monitoring report	A report prepared by a project participant that sets out the GHG emission reductions or net GHG removals of an implemented registered CDM project activity for a particular monitoring period.
Net anthropogenic GHG removals by sinks	In the context of A/R CDM project activities, the actual net GHG removals by sinks minus the baseline net GHG removals by sinks minus leakage.
Non-Annex I Parties	Parties to the Convention that are not included in Annex I to the Convention.
Project design document	The document prepared by the project participant of a CDM project activity which sets out in detail, in accordance with the CDM rules and requirements, the CDM project activity which is to be undertaken.
Reforestation	The direct human-induced conversion of non-forested land to forested land through planting, seeding and/or the human-induced promotion of natural seed sources, on land that was forested but has been converted to non-forested land.
Smallholder*	Smallholder is a person who owns or runs a smallholding in a general term. The World Bank defined a smallholder as a holder of less than 2 ha of cropland (WB 2003).
Small-scale A/R CDM project	An afforestation or reforestation project: where the average projected net anthropogenic GHG removals by sinks for each verification period do not exceed 16,000 tCO_2 /year; and which is developed or implemented by low income communities and individuals as determined by the host Party.

Small-scale farmer*	A smallholder in Paraguay is defined as a small-scale farmer who owns less than 20 ha of land.
Temporary CER	A unit issued pursuant to Article 12 of the Kyoto Protocol for an A/R CDM project activity, which expires at the end of the commitment period following the one during which it was issued. It is equal to one metric tonne of CO_2 equivalent.
Transaction cost*	Transaction cost includes cost of negotiating, contracting, implementing, and monitoring a project. For CDM projects, transaction cost also includes cost of registering, verifying, and certifying a project, which is usually independent of the project size (Jindal et al. 2008).

Note) Source: UNFCCC 2012e. The terms marked (*) are defined by the author for this paper or cited from other sources except UNFCCC 2012e.

List of tables and figures

Summary

Kyoto Protocol, established in 1997, has set emission reduction targets, and introduced Kyoto mechanisms including Clean Development Mechanism (CDM), as an auxiliary means for achieving the numerical emission reduction targets for Annex I Parties (developed countries). The purpose of the CDM is to assist Parties not included in Annex I (developing countries) in achieving sustainable development and to support Annex I Parties in achieving their quantified reduction commitments.

Of the various types of CDM projects, afforestation/reforestation CDM (A/R CDM) project was considered to have a great impact on smallholders. However, the number of A/R CDM projects, registered with the Executive Board of CDM (CDM EB), was only 45 by the end of December 2012, and few CERs (Certified Emission Reduction, or carbon credit from CDM) had been issued.

In the world, Latin America and Caribbean Countries (LACs) had highest potential of sequestrating CO_2 in woody biomass; however, LACs had few A/R CDM projects which targeted smallholders. The followings relating to A/R CDM project involving smallholders in LACs were not clear: (1) solving issues to realize an A/R CDM project; (2) economic feasibility of an A/R CDM project; (3) reduction of the transaction cost; (4) contribution to sustainable development; and (5) effectiveness of agroforestry for farmers. The objective of the study is to verify the effectiveness of A/R CDM project involving smallholders, in order to examine the contribution of A/R CDM project to smallholders and rural communities in LACs.

For the study, first, the author examined the general issues relating to A/R CDM projects through finding difficulties of the methodologies and analyzing A/R CDM projects already registered with the CDM EB by the end of 2012 in order to clarify actual state of A/R CDM projects. Second, the author selected Paraguay as a country for the study, because Paraguay was the best suited for analyzing actual A/R CDM project involving smallholders in the South America, where the largest deforestation was recorded in LACs. The author examined the process of the A/R CDM project developed in Paraguay, starting from the selection of unorganized communities in a low income area, followed by community workshops, overcoming the difficulties related to A/R CDM project, registration with the CDM EB, forestation activity, monitoring activity, and acquisition of carbon credit. Subsequently, project cost, benefit to participant farmers, and achievement of agroforestry activities of the A/R CDM project in Paraguay were evaluated. The contribution of the A/R CDM project to sustainable development was analyzed by the survey results from project participant farmers and stakeholders. In addition, the significance of agroforestry in the A/R CDM project in Paraguay was analyzed based on the performance of farmers and experimental results at the demonstration farm that was established in the project area.

This study found that the implementation of an A/R CDM project involving smallholders was possible in Paraguay, by solving the challenges associated with the complicated rules of A/R CDM projects. However, the large difference in tree growth among farmers’ forested land affected

mainly by drought and poor management, caused excessive loss of work done and resulted in a decrease of forested area possible to be monitored by 62 % of the planned area and decrease of carbon credit by 71 % of the planned amount.

Further, this study clarified that: (1) carbon credit price of more than USD 31/ tCO_2 was required if an A/R CDM project was implemented locally in Paraguay without external assistance and to cover all expenses with the first carbon credit; (2) forestation activity by beneficiary pays principle (BPP) was effective for ownership building of farmers and cost-saving; (3) a forestation project contributed to the sustainable development in low income rural area even without development as an A/R CDM project; (4) agroforestry with *Grevillea robusta* (500 trees/ ha) was possible for crop production for 3-4 years after planting without thinning, in spite of generating few carbon credit amount to cover the expenses.

The study proved that the hypothesis that an A/R CDM project involving smallholders contributes to improvement of rural livelihood was wrong, and financially unfeasible even in the best carbon market conditions, while a forestation project itself would give large impact to rural communities where degradation of natural resources were ongoing.

The CER price of CDM projects was at a peak in 2006, maintained at about USD 3- 5/ tCO_2, however, had sharply declined in 2012 before the first commitment period of the Kyoto Protocol ended, and fallen to rock-bottom levels in 2013. In this situation, it is impossible to obtain CER worth covering the transaction cost, and the additionality, which is an essential requirement for a CDM project, has become meaningless. An A/R CDM project should be advised to apply carefully in order that developing countries do not mistakenly have excessive expectations for this mechanism, unless fundamentally new mechanisms, e.g. allowing the use of official development assistance and public funds to the project, are introduced.

Forestation along with agroforestry is a simple method to sequestrate greenhouse gas, and is expected to ensure co-benefits in rural areas of developing countries where the potential area to be forested is widely distributed. Therefore, forestation projects for smallholders should be promoted, without taking into account A/R CDM mechanism. If forestation is implemented in the areas with high needs of forestation and based on BPP, incentives to farmers will be limited to technical guidance and supply of seedlings, because project promoter could mobilize farmers to provide their own resources such as labor, land and local materials.

1 Introduction

1.1 Background of CDM and significance of A/R CDM

The Intergovernmental Panel on Climate Change (IPCC) reported that “eleven of the last twelve years (1995-2006) rank among the twelve warmest years in the instrumental record of global surface temperature (since 1850)” and the temperature increase was widespread throughout the globe (IPCC 2008). In addition, according to the World Meteorological Organization, “the period 2001–2010 was the warmest decade on record since 1850” (WMO 2013). “The global average temperature of the air above the Earth’s surface over the 10-year period was estimated to have been 14.47°C±0.1°C” (ibid.). “Global temperature increased at an average estimated rate of 0.17°C per decade during 1971‐2010, while the trend over the whole period 1880–2010 was only 0.062°C per decade” (ibid.). “Global-average atmospheric concentrations of carbon dioxide rose to 389 ppm in 2010 (an increase of 39 per cent compared to pre-industrial times)” (ibid.). IPCC declared that “human influence on the climate system is clear” (IPCC 2013).

Climate damage is “disproportionally impacting the poor, who are the least resilient and most vulnerable” (WB 2012). “From 1970-2008, over 95 % of natural-disaster-related deaths occurred in developing countries” (ibid.).

Practical moves responding to climate change commenced after the Ministerial Declaration of the Second World Climate Conference was adopted in November 1990. Based on this declaration, the United Nations Framework Convention on Climate Change (UNFCCC) was created in May 1992 in New York. This convention was concerned “that human activities have been substantially increasing the atmospheric concentrations of greenhouse gases (GHGs), that these increases enhance the natural greenhouse effect, and that this will result on average in an additional warming of the Earth's surface and atmosphere and may adversely affect natural ecosystems and humankind,” and had ultimate objective of stabilization of GHG concentrations in the atmosphere (UN 1992).

The UNFCCC was adopted at the United Nations Conference on Environment and Development (Earth Summit or UNCED) held in Rio de Janeiro in June 1992, and signed by more than 150 countries. Then, in March 1994, UNFCCC came into force with its ratification by more than 50 countries.

The Conference of the Parties (COP) for UNFCCC has been held every year since 1995 the year after the Convention began. At the 3rd Conference of the Parties (COP3) held in Kyoto in December 1997, the Kyoto Protocol (KP) was agreed. The KP set emission reduction targets for Annex I countries (developed countries), and introduced the Kyoto mechanisms consisting of three mechanisms of joint implementation, clean development mechanism, and emissions trading as an auxiliary means for achieving the numerical targets for Annex I countries, through taking advantage of market mechanisms (UN 1998).

Clean Development Mechanism (CDM) as one Kyoto Mechanism, is a mechanism to share carbon credit (certified emission reduction or CER) among project participants from Annex I countries, which have a numerical target to reduce GHG, and host countries (developing countries), that have no reduction target, based on the emission reductions achieved through implementing emission reduction projects in the host country. It is possible for Annex I countries to “use the certified emission reductions accruing from such project activities to contribute to compliance with part of their quantified emission limitation and reduction commitments” (UN 1998).

KP stated that the first purpose of CDM is to “assist parties not included in Annex I in achieving sustainable development” (UN 1998). KP created new opportunities for developed countries to support the effort of developing countries to reduce GHG emission and provide them technologies and funds for their emission reduction activities. However, many CDM projects were focused on reducing GHG emission efficiently and biased towards specific regions and sectors, because CDM was principally based on profit-oriented market mechanism and investment by private entities.

In developing countries, 55 % of the population was living in rural areas (IFAD 2010), and share of agricultural production in gross domestic product (GDP) was high. Taking the 50 least developed countries (LDCs) around the world at the moment of 2010, the population has increased at a rate of 2.4 % per year, the rural population exceeded 70 %, and the agricultural population was 65 % (FAO 2011). The share of GDP of agriculture, forestry and fisheries of LDCs exceeded 25 %, significantly greater than the global average (less than 3 %), but the labor productivity was much lower, due to the large agricultural population ratio (WB 2011a). Of the 1.4 billion poor people, one billion people lived in rural areas and the majority of the poorest depended on agriculture for their livelihood (IFAD 2010).

With the increase in population, local resources of land, water, and vegetation have been degraded. Especially, degradation of forest resources was considerable and progressed continuously. The net change in forest area in the period 2000–2010 was estimated at -5.2 million ha per year (FAO 2010). Agricultural land increased 3.5 million ha annually, including the disorderly development of marginal land with low productivity (FAO 2011). By the change and degradation of forest, GHG emissions proceeded at the scale of the 17.4 % of emissions worldwide in total in 2004 (IPCC 2008). In order to stabilize CO_2 concentrations at 450 ppm, cumulative emissions over the 21st century should be reduced to less than 1,800 $GtCO_2$ from the 2,460 $GtCO_2$ determined without consideration of carbon cycle feedbacks (ibid.). Afforestation, reforestation, conservation of forest, and carbon sequestration in farmland soil were noted as measures to remove GHG at the lowest cost. The CDM projects, which sequestrate GHG to the forest and agricultural land, were expected to bring a new source of income in rural areas of developing countries, because they gave an incentive for forest development and farm land management, as well as removal of GHG.

The Marrakech agreement and decisions on modalities and procedures relating to GHG removals through land use, land-use change and forestry (LULUCF) projects in 7th Conference of the Parties (COP7) in 2001 made it possible to integrate recovery of resources in rural areas with GHG removal.

In developing countries, “all policies related to forest-based mitigation and adaptation to climate change need to be linked with rural development and agricultural policies that focus on people, poverty alleviation, food security and livelihoods” (FAO 2012a).

The CDM Executive Board (CDM EB), through the Afforestation and Reforestation Working Group (A/R-WG), examined methodologies for afforestation and reforestation CDM (A/R CDM) projects and determined 21 methodologies from 2005 to 2011. In 2006, the first A/R CDM project, formulated in China with the support of the BioCarbon Fund (BCF) of the World Bank (WB), was registered with the CDM EB (UNFCCC 2006).

Registration of the A/R CDM project in the CDM EB did not proceed well. After the second project was registered in 2009, the number of registered projects increased, resulting in 45 projects commenced by the end of the first commitment period of the KP (31 December 2012).

A/R CDM projects were considered to have a great impact on rural poors and low income rural communities (WB 2011b). The number of registered A/R CDM projects, in which the smallholders participated, was 31 by the end of the first commitment period. Among them, 15 of the projects were formulated to forest the lands where smallholders provided a part of their tenure, though the other 16 projects were planned on public land or communal land to be forested (UNFCCC 2013a). Here, smallholders were defined as those with less than 2 ha of land area (WB 2003). Smallholders depended on household members for most of the labor (IFAD 2009).

In order to improve livelihood, smallholders must cope with natural resources degradation (IFAD 2010). It was conceivable that the introduction of agroforestry (AF) and forestation in abandoned infertile farmland, in addition to soil conservation and restoration of soil fertility, could achieve effective use of the land. If A/R CDM projects were conducted on land no longer suitable for agricultural production, farmers could obtain benefit from forestation and income from carbon credit. The land for forestation and AF was limited for smallholders. If the small land areas are integrated within communities or districts, the possibility of A/R CDM projects will be enhanced.

Latin America and Caribbean countries (LACs) have high potential for forest conservation and forestation for sequestrating CO_2 in woody perennial biomass, because LACs was where the largest annual forest loss in the world was recorded (FAO 2012c), and 46 % of annual emissions was due to the land use change (de la Torre et al. 2009). Among LACs, Brazil accounted for 88 per cent of the total aggregate emissions from the region for the LULUCF sector (UNFCCC 2005e). According to the Inter-American Development Bank, the potential of afforestation/reforestation in LACs was roughly estimated at 70 million ha and would result in the sequestration of 18 $GtCO_2$ (Gardi et al. 2010). The area available for forest restoration was about 335 million ha and would sequester at least 46 $GtCO_2$ (ibid.). “A form of afforestation of particular interest to LAC countries was the use of agroforestry systems” (ibid.).

High potentiality of A/R CDM in LACs was demonstrated by the fact that 17 A/R CDM projects have already been registered with the CDM EB by the end of 2012. However, forestry CER in LACs was issued for only one A/R CDM project at the end of 2012, which was large-scale industrial plantation project in Brazil managed by one company (UNFCCC 2009c), though forestation and forest conservation project oriented to voluntary carbon market has been tried (Salazar et al. 2002). LACs were well endowed in natural resources, however, “rural areas have the highest incidence of poverty” (WB 2003). “Degradation weakens the resource base, exacerbates the impact of natural calamities, and worsens the vulnerability of the poor” (ibid.). The priority to examine the effectiveness of A/R CDM projects including AF for smallholders in LACs is high in order to recover their land productivity and to improve their livelihood.

1.2 Previous discussions on A/R CDM

Studies on forestry carbon projects have been advanced since KP was signed in 1997. These include policy recommendations (Smith 2002, Stern 2006, etc.), framework of A/R CDM projects and possibility of GHG sequestration (Waterloo et al. 2001, Blaser et al. 2007, etc.), desk review of CDM projects (Wittman 2012, etc.), analysis of ongoing individual project (Peskett et al. 2010, etc.), and analysis of emission trading market (Morera 2007, Maslin et al. 2011, WB 2012, etc.).

For the aspect of A/R CDM project which was assumed to have contribution to smallholders and communities, various discussions were made.

At early stage of CDM, Smith et al. expected that A/R CDM would offer “an unprecedented opportunity for capital flows into economically impoverished forest regions” (Smith et al. 2002). Also, Angelsen et al. assumed that “even a small market share for poor people’s carbon forestry could be an important contribution to poverty reduction” (Angelsen et al. 2003). Peskett et al. stated that motivations for investment in A/R CDM were thought to have “a strong bias towards social responsibility” from the outset (Peskett et al. 2006). “Many of the traditional barriers to involving small producers in investment opportunities were absent in the production of carbon offsets through forestry” (ibid). IFAD reported that “growing attention was being given both to issues of adaptation to climate change in smallholder agriculture, and to ways in which poor rural people can participate in, and benefit from market opportunities linked to environmental services and climate change mitigation” (IFAD 2010). Gardi et al. stated that “A/R CDM, especially small-scale projects, offered a possibility to low income communities to get involved, particularly through the promotion of community forestry, which could have an important developmental impact in rural areas” (Gardi et al. 2010).

Those previous studies above were related to principles, economic efficiency and institutional design of the A/R CDM mechanism. The majority of them were expectations or suggestions rather than result-based evaluation. As a matter of importance for A/R CDM mechanism, it was not verified concretely that the A/R CDM projects would contribute to improvement of smallholders’ livelihood and of communities.

The transaction cost and carbon revenue of A/R CDM projects were studied especially on small-scale projects which had high social value. Transaction costs have been “a major reason why small-scale projects involving many individual farmers have been less attractive to the carbon offset industry” (Peskett et al. 2010). The WB indicated that “project developers had little incentive to engage in small scale projects" (WB 2011b). The dispersion of participant smallholders could also "increase the transaction costs of communicating with and travelling to smallholders in the process of designing and ensuring implementation of contracts" (Cacho et al. 2003). Because of CDM transaction costs, small-scale projects would not "benefit from carbon trading, even if the simplified modalities and procedures developed for small-scale projects were applied to them" (Locatelli et al. 2008). Chomitz et al. stated "measurement, monitoring and transactions costs were prohibitively high at the property level, especially for small properties" (Chomitz et al. 2006).

On the other hand, the possibility of reduction of transaction cost was considered through involving smallholders and communities (Cacho et al. 2003, Skutsch 2005) or "aggregators who combine activities over many smallholders" (WB 2010). The simplified small-scale A/R CDM modalities and procedures established in 2005 (UNFCCC 2005c) was also expected to lead to reduction of transaction costs. Locatelli et al. showed that "the probability for a small‐scale project being favored by simplified modalities and procedures was less than 2 % if the transaction cost reduction was 20 or 50 %" (Locatelli et al. 2008). Countries that have most of their A/R CDM possibilities in the small‐scale category may have "only a marginal participation to the CDM" (Locatelli et al. 2006).

The low carbon revenue was also recognized. Shames stated that "carbon payments that accrue to individual smallholders will likely be very small relative to their total income" (Shames 2013). Derwisch et al. found that "timber revenues are the main source of income in plantation forestry and that CER revenues, accounting for less than 1 % of the timber revenues, represent only a small additional incentive" (Derwisch et al. 2009). Angelsen et al. stated that "the carbon price could be very low and could make many pro-poor projects uneconomical, it would take specific intervention to reduce the high transaction costs of implementing projects with smallholders" (Angelsen et al. 2003). Consequently, high transaction cost and low revenue of A/R CDM projects especially involving smallholders were predicted on the basis of trial calculations with various conditions or through analysis on existing pilot forestry carbon projects. However, as there were no A/R CDM projects to reach final stage to acquire CER by April, 2012, the scale of financial feasibility of A/R CDM projects was not verified.

For research on forestry carbon projects involving smallholders, the importance of AF was highlighted. According to Boyd et al., "the unexploited benefits of agroforestry systems for carbon sinks suggest that such systems can make significant contributions to greenhouse gas emissions reductions" (Boyd et al. 2005). FAO regarded AF as "an essential component of global efforts both to enhance rural livelihoods and to mitigate climate change" (FAO 2012b). Place et al. stated that "the importance of smallholder agroforestry is only likely to be reinforced with increased attention and resources to climate change adaptation and mitigation" (Place et al. 2012). Jindal et al. suggested encouraging adoption of AF "by paying local communities for generating carbon sequestration offsets" (Jindal et al. 2008). Cacho et al. considered that landholders were likely to adopt AF, "if they perceived agroforestry better satisfied their goals than their current land use practices, and if they believe that it does not introduce unacceptable risks" (Cacho et al.

2003). Locatelli et al. indicated that AF in general would be particularly appealing to small farmers “because they cannot sacrifice agricultural area to pure forest plantations” (Locatelli et al. 2006). Smith et al. stated that among reviewed 56 AF practices in eight countries, “a majority was profitable and, in 40 % of cases financial returns were at least 25 % higher than alternative farming practices” (Smith et al. 2002). The importance of AF for improving livelihood of smallholders and removing GHG was recognized, however, there were no studies to verify it on the result-based analysis of A/R CDM projects including AF.

There were researches about registered A/R CDM projects that focused on smallholders and low income rural areas, such as in India (Basu 2009, Gera et al. 2010, Gera et al. 2011), Ethiopia (Brown et al. 2011), Vietnam (Yamanoshita et al. 2012), Senegal (Rennaud et al. 2012), and Panama (Derwisch et al. 2009). The WB analyzed 21 CDM projects funded through BCF (WB 2011b). In those researches, there were no result-based analyses on effectiveness and financial viability of A/R CDM projects, because no forestry CER was issued before April, 2012. In addition, it was difficult to analyze financial feasibility because the financial data were kept confidential by the project promoters.

The analysis of forestry carbon projects not registered with the CDM EB was also conducted, such as in Uganda (Nakakaawa et al. 2010), Central Africa (Sonwa et al. 2011), China (Brodnig 2009, Li et al. 2012), Mozambique (Palmer et al. 2009), Nepal (Staddon 2009), and the Philippines (Lasco et al. 2010). For regional forest carbon projects, analysis on Latin America (Salazar et al. 2002, de la Torre et al. 2009), and a report on the forestry carbon project for smallholders in Africa (Shames 2013) have been published. The result-based analysis on effectiveness and financial viability of forestry carbon projects were not conducted as similar to the A/R CDM projects, albeit voluntary carbon credits were issued for some projects.

Past researches and studies disclosed the problems of A/R CDM projects, e.g. non permanence, land rights, and low CER price (Locatelli et al. 2003, Cacho et al. 2003, Basu 2009, Morera et al. 2007, Locatelli et al. 2008, Peskett et al. 2010, WB 2012, etc.). However, there were no quantitative research results from A/R CDM projects based on actual achievement including the way to solve the problems as well as the effectiveness of A/R CDM projects to participant households.

1.3 Objectives of the study

The objective of the study is to verify the hypothesis that "a carbon benefit obtained from an A/R CDM project involving smallholders improves the lives of smallholders." The hypothesis was set implicitly under UNFCCC by including a requirement that the small-scale A/R CDM project should be “developed or implemented by low income communities and individuals” if applying simplified modalities and procedures for small-scale A/R CDM project (UNFCCC 2005c). The BCF, the principal financing institute to develop A/R CDM projects, stated that one of the financing objectives was to directly benefit poor farmers (BCF 2013). At the stage that it was unproven how an A/R CDM project should be designed to contribute to improvement of smallholders' livelihood, an A/R CDM project involving smallholders should satisfy all the following premises.

Premise 1: CER could be issued to an A/R CDM project involving smallholders.
Premise 2: Carbon benefit could be obtained by selling CER to buyers at the price greater than the transaction cost.
Premise 3: Participant smallholders could obtain benefit from the A/R CDM project.

Upon analysis, the issues associated with each premise were set. The assumptions were set for each issue in line with the current state of A/R CDM projects.

For the premise 1, the following issue with assumptions was set:

Issue 1: How could the requirements of an A/R CDM project be solved to obtain CER?

(1) Formulating an A/R CDM project and obtaining CER will be more difficult than emission reduction CDM projects, because of characteristics of forest.
(2) The institutional requirements, especially clarifying land rights (WB 2011b) and organizing smallholders, will be more difficult to solve than technical requirements, and will be crucial to develop an A/R CDM project.
(3) A proper participatory approach, if applied, will lead to increase the awareness of unorganized farmers in the direction to foresting their own degraded lands.

For premise 2, the following 2 issues with assumptions were set:

Issue 2: How economically feasible is an A/R CDM project?

(1) A certain size of project with land area to be forested and number of farmers should be organized to ensure the feasibility of A/R CDM project (Schoene et al. 2005).
(2) The work to formulate and monitor an A/R CDM project by organizing plenty of farmers will require high cost and long time, with low CER due to relatively small size of forestation area and low carbon stocks increase, if comparing to a large-scale industrial forestation project (Malmsheimer et al. 2011).
(3) The performance of farmers who would be unskilled for forestation will be poor if comparing to an industrial forestation A/R CDM project.

Issue 3: To what extent is it possible to reduce the transaction cost of an A/R CDM project?

(1) Out of transaction cost, the cost for the designated operational entity (DOE) responsible for validation and verification of an A/R CDM project will be almost fixed and the reduction will be unlikely.
(2) The possibility to reduce transaction cost relating to formulation and monitoring of an A/R CDM project involving smallholders will be small due to the inefficiency of

organizing smallholders and collecting data from them, if comparing to an industrial plantation A/R CDM project.

(3) If awareness raising activities are successful, the reduction of forestation cost will be somewhat possible.

For premise 3, the following 2 issues with assumptions were set:

Issue 4: To what extent does an A/R CDM project contribute to the sustainable development of the project area?

(1) If awareness raising activities are successful, satisfaction of farmers in the forestation project will be so high that the sustainability of forestation may be feasible.

(2) If no carbon benefit is realized, the sustainability of A/R CDM to obtain CER will not be achieved.

Issue 5: How is AF, which is a desirable alternative for smallholders' land use and a part of an A/R CDM project, effective?

(1) Farmers will participate in AF activities when they understand the benefit, because AF will create forest benefit without disturbing crop production if properly conducted.

(2) The financial condition of project promoter will be exacerbated when AF is included, since acquisition of CER will be small if comparing to monoculture forestation due to low density of forestation.

(3) Farmers will have more benefit from AF than from conventional farming (FAO 2012b).

The verification should be conducted on the basis of results as quantitatively as possible, through analyzing an actual A/R CDM project involving smallholders.

LACs region should be selected as an objective to verify the hypothesis. LACs is a region where carbon removal in the LULUCF sector is the most promising, because emission from LULUCF sector in LACs has been largest in the world. Significance to demonstrate the hypothesis for LACs is high. The country for the study should be selected in order that the results of the study would be applicable to the LACs in as much as possible. The country should be selected within 12 countries of the South America[1], where the largest deforestation was recorded in the LACs. In accordance with the objective of the study to verify the hypothesis set for A/R CDM project involving smallholders, the country for the study should be selected on the criteria of low income, high weight of agricultural value added, high percentage of rural population and poverty, along with rapid deforestation. In order to find the difficulty of domestic procedures for CDM, the

[1] Twelve countries of the South America are Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Guyana, Paraguay, Peru, Suriname, Uruguay, and Venezuela.

number of registered CDM projects implying a capability degree of a country to promote CDM development was added as one of the criteria.

The following conditions were set to examine the criteria to select a country based on available data from IFAD 2010, WB 2013b, UNFCCC 2005e, and UNFCCC 2013a (see Annex 1):

(1) GDP per capita was lower than USD 3,000;
(2) Agricultural value added was more than 10 % of GDP;
(3) Percentage of rural to total population was more than 20 %;
(4) Percentage of people living under USD 1.25/ day was more than 5 %;
(5) Percentage of people living under USD 2.0/ day was more than 10 %;
(6) Arable land per head of agricultural population was more than 1.0 ha;
(7) Average annual deforestation rate was more than 0.5 %;
(8) Emission from LULUCF sector was larger than removal (positive %);
(9) Number of registered CDM projects was less than 10.

The country applicable to all the above conditions was Paraguay only. It should be noted that Bolivia was a high potential candidate, because the country was one of the poorest countries in the South America, with the highest proportion of emission from LULUCF sector in GHG emission total, and second highest percentage of rural population in the continent. However, Bolivian government was promoting non-market mechanism in the discussion under UNFCCC (Bolivia 2012), and placed no priority on market-based mechanism such as A/R CDM. This made almost impossible to acquire forestry CER in the country. Therefore, Paraguay was selected as a country for the study. In order to verify the hypothesis above in LACs, the author analyzed the A/R CDM project involving smallholders in Paraguay, which won CER in August 2013. The A/R CDM project in Paraguay was the first project to acquire CER in LACs as an A/R CDM project involving smallholders, who did forestation activities in their own land. Owing to land richness, the smallholders in Paraguay were defined as small-scale farmers (SSFs) who owned less than 20 ha of land, contrary to the general definition of smallholders who owned less than 2 ha of cropland. The SSFs in Paraguay, depending on household members for most of the labor, constituted a large part of the households below poverty line in rural area.

There were no precedent researches on analysis of the actual A/R CDM project based on the results of CER acquisition. From the results of the study, every issue is discussed in order to find if the premises are satisfied. Consequently the hypothesis that a carbon benefit obtained from an A/R CDM project involving smallholders improves the lives of smallholders is examined.

1.4 Framework of the study

A survey of existing literature was conducted at first. The methodologies and decisions of the COP of UNFCCC and of the Conference of the Parties serving at the meeting of the Parties to the Kyoto Protocol (CMP) were examined to implement an A/R CDM project involving smallholders. A survey of existing literature and methodologies confirmed the issues and difficulties of A/R CDM projects in section 2.2.

The realized A/R CDM projects were so few that it was necessary to take into account of registered A/R CDM projects. The project design documents (PDD) and monitoring reports of A/R CDM projects registered with the CDM EB by the end of the first commitment period of the KP were examined to find the present state of registered A/R CDM projects (2.3). The current situation of A/R CDM projects was discussed in section 2.4.

For examining the premise 1 that CER could be issued to an A/R CDM project involving smallholders, an A/R CDM project was established in Paraguay. The implementation process how to solve the requirements of an A/R CDM project involving smallholders to obtain CER in Paraguay was examined as follows:

(1) Activities prior to an A/R CDM project (3.3);
(2) Formulation and implementation of an A/R CDM project (3.4);
(3) Pre-monitoring activities to establish a monitoring system to obtain CER (3.5);
(4) Monitoring activities and acquisition of CER (3.6).

The premise 1 was discussed in section 3.7 along with clarifying the issue 1: how the requirements of an A/R CDM project could be solved to obtain CER.

For examining the premise 2 that carbon benefit could be obtained by selling CER to buyers at the price greater than the transaction cost, the economic feasibility of the A/R CDM project realized in Paraguay was analyzed at first (4.3). Subsequently the possibility of reducing transaction cost was examined (4.4).

The premise 2 was discussed in section 4.7.1 and 4.7.2 along with clarifying the issue 2: how economically feasible an A/R CDM project is, and the issue 3: to what extent it is possible to reduce the transaction cost of an A/R CDM project.

For examining the premise 3 that participant smallholders could obtain benefit from the A/R CDM project, the results of questionnaire surveys on participant farmers of the A/R CDM project and an evaluation survey conducted by the third party were analyzed (4.5). In addition, the significance of AF in the A/R CDM project in Paraguay was analyzed based on the performance of farmers and experimental results at the demonstration farm that was established in the project area (4.6).

The premise 3 was discussed in section 4.7.3 and 4.7.4 along with clarifying the issue 4: to what extent an A/R CDM project contributes to the sustainable development of the project area, and the issue 5: how is AF, which is a desirable alternative for smallholders' land use and a part of an A/R CDM project, effective.

The results of discussion relating to the current situation of A/R CDM projects and the A/R CDM project in Paraguay were summarized in section 5.1 and 5.2, with corresponding to 3 premises and 5 issues. Finally whether a carbon benefit obtained from an A/R CDM project involving smallholders improves the lives of smallholders or not was verified in section 5.3.

The study was concluded in section 5.4.

The structure of the study mentioned above is shown in Figure 1.1.

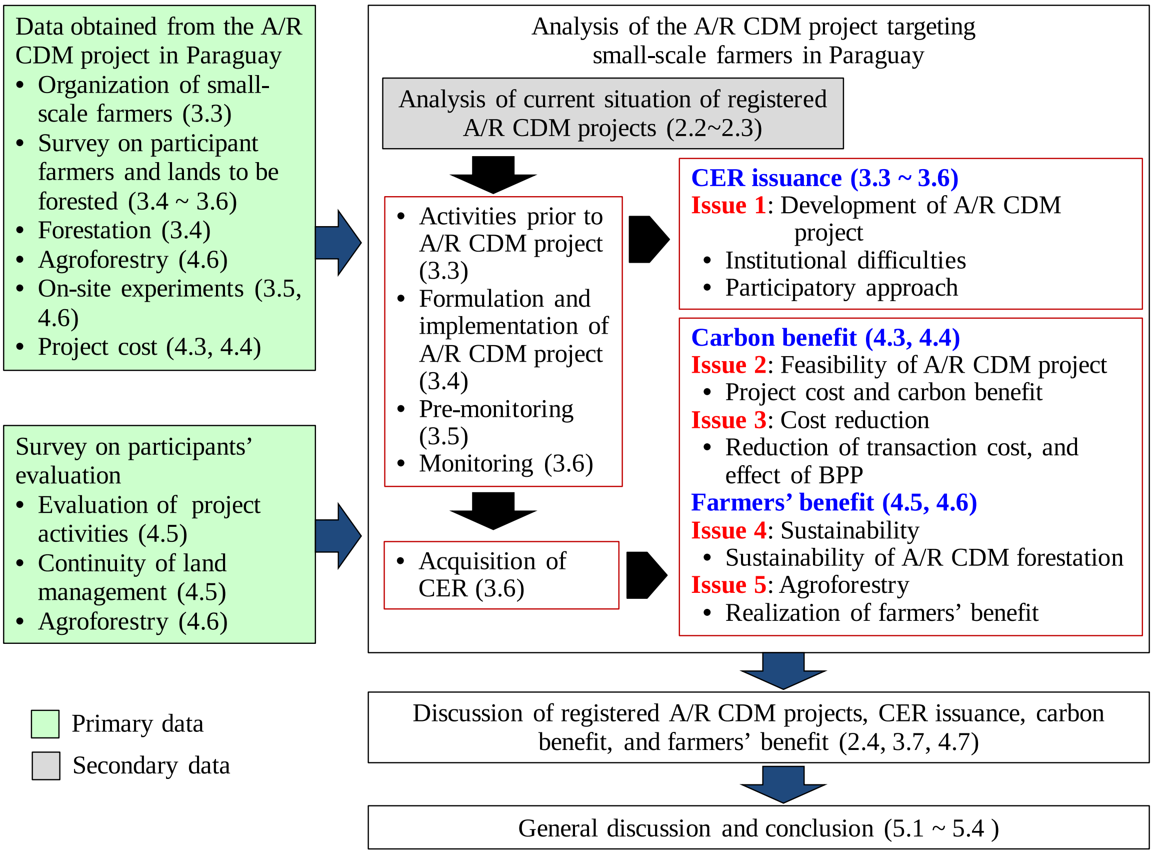

Figure 1.1. Structure of the study. The number in parentheses placed after item indicates the number of chapter or section where the contents of the item were described.

2 Current situation of A/R CDM projects

2.1 Introduction and methods

A/R CDM is one of 15 sectors consisting of CDM projects. CDM projects are intended to reduce GHG emissions, but the A/R CDM project is the only project that is aimed at removal of GHG from the atmosphere. CDM projects should be formed on the basis of CDM methodologies, which set the scope of application, the method to estimate baseline emissions, the monitoring method of emission reductions, etc. to issue CER. For a CDM project, a PDD that satisfies all the contents of selected CDM methodology and relevant decisions/resolutions of COPs and CMPs must be prepared, based on the findings of various surveys and studies. After formulating a CDM project, validation of the project to register with the CDM EB is followed. A DOE registered with the CDM EB conducts validation work. Request of registration is submitted to the CDM EB by DOE. The CDM EB determines the validity of the project for registration. CER is issued after the CDM EB justifies the documents prepared by DOE who verifies monitoring results of the project before the request of issuance of CER to the CDM EB. Project promoter formulates a CDM project according to methodology and procedures, implements the project, and conducts monitoring activity to evaluate the amount of GHG emission reduction. The project promoter needs to clear DOE's verification on the monitoring results.

As different from emission reduction CDM projects, an A/R CDM project is influenced by the characteristics of forest, such as: (1) non-permanence (CO_2 is emitted again after loss of forest); (2) uncertainty (accurate estimation of CO_2 removal is impossible); and (3) long period (a long period is required for the growth of forest) (FFPRI 2006). About non-permanence, the CDM rule requires project promoter to choose either temporary CER (tCER) or long-term CER (lCER) (UNFCCC 2005b). The value of these CERs will expire when the time limit has come, therefore, each national registry should include a replacement account of those forestry CERs in order to replace them prior to expiry by assigned amount units (AAUs), permanent CERs, emission reduction units (ERUs), etc. (UNFCCC 2005b). A/R CDM project pales compared to the CDM project to reduce emissions without the need of compensation, and the unit price of tCER and lCER has been underestimated. According to estimates under a discount rate of 3 %, tCER that expired after 5 years had a value of only 14 % of a permanent credit (Morera et al. 2007). For non-permanence, the forestry CER was excluded from the EU Emissions Trading System (EU ETS), which accounted for more than 80 % of the carbon trading in the world (WB 2012). As for the uncertainty of forest, investment risk was great for the project promoter, because the estimation of accurate accumulation of CO_2 in forested areas was difficult due to the difference of growth rate of each species, and difference of natural conditions such as topography, soil, and climate, as well as anthropogenic conditions relating to forest management. The long period necessary for forest to mature exposed the forested area to damage caused by drought, pests, diseases, and forest fires; thus enhanced the investment risk further.

In order to formulate an A/R CDM project, it was necessary to clear the difficulties such as additionality, eligibility of land, clarification of land rights/CER rights, estimation of carbon stocks change in forest, assessment of environmental impact, and procedures of designated national authority (DNA).

Approximately 14,000 projects were validated for registration till the end of the first commitment period of the KP on 31 December 2012; however, the number of projects that were actually registered was about 7,000 (including those belonging to several sectors). This indicated that only the half of the projects formulated as CDM projects were registered. The number of CDM projects which have successfully acquired CERs during the first commitment period was 1,902, corresponding to 35 % of the registered CDM projects.

On the contrary, the number of A/R CDM projects registered with the CDM EB was 45 at the end of the first commitment period of the KP. This corresponded to 0.8 % of the total number of 5,447 registered CDM projects at the time. With respect to CER issuance amount, the CER of A/R CDM project was 5.6 million tCO_2, which was only 0.5 % of more than 1 billion tCO_2 of CER issued by the CDM EB. The validated A/R CDM projects were 94, and the rate of registered projects to validated ones was 48 %. On the other hand, the number of A/R CDM projects which acquired forestry CER was 6, corresponding to only 13 % of the registered A/R CDM projects.

In the following sections, the difficulties of A/R CDM project were clarified through examining published methodologies and decisions/resolutions of COPs and CMPs. The current situation of implementation of A/R CDM projects registered with the CDM EB was analyzed according to location, scale, project participants, land tenure, selection of tree species, AF, incentive for forestation, and acquisition of forestry CER, based on the published data of UNFCCC, and PDDs including monitoring reports relating to registered A/R CDM projects.

2.2 Difficulties of A/R CDM project

For the formulation of CDM projects, a lot of difficulties caused by complex constraints of CDM methodologies and procedures should be solved. The difficulties of A/R CDM projects include common ones to the difficulties of CDM projects such as demonstration of additionality, assessment of environmental impact, and procedures of DNA. Difficulties unique to A/R CDM projects are derived from lands used for forestation and the characteristics of forest (non-permanence, uncertainty, and long period) such as eligibility of land, clarification of land rights/CER rights, and estimation of carbon stocks change in forested land. The contents of these difficulties are as follows.

(1) Additionality

A CDM project should be “additional to any that would otherwise occur” (UN 1998). This means that “a CDM project activity is additional if anthropogenic emissions of GHGs by sources are reduced below those that would have occurred in the absence of the registered

CDM project activity” (UNFCCC 2001b). This is called additionality, and a tool to prove additionality is provided (UNFCCC 2007a). For an A/R CDM project, additionality was one of complications, which disturbed registration with the CDM EB, because it was necessary to prove that forestation would not be conducted in the project area without an A/R CDM project.

(2) Eligibility of land

Target areas for an A/R CDM project must be “lands that did not contain forest on 31 December 1989” (UNFCCC 2005d). DNA of non-Annex I countries needed to “select a single minimum tree crown cover value between 10 and 30 per cent, a single minimum land area value between 0.05 and 1 ha and a single minimum tree height value between 2 and 5 meters” as a definition of forest in the country (UNFCCC 2005d). In order to demarcate a project area, confirmation was necessary that: (1) vegetation on the land was below the forest thresholds; (2) all young natural stands and all plantations on the land were not expected to reach the minimum crown cover and minimum height chosen by the host country to define forest; and (3) the land was not temporarily unstocked, as a result of human intervention such as harvesting or natural causes (UNFCCC 2007b). In the end, it should be demonstrated that the land was not forest on 31 December 1989, through: (1) aerial photographs or satellite imagery complemented by ground reference data; or (2) land use or land cover information from maps or digital spatial datasets; or (3) ground based surveys (land use or land cover information from permits, plans, or information from local registers such as cadastre, owners registers, or other land registers) (ibid.).

(3) Land rights/CER rights

The boundary of an A/R CDM project consisted of integrated individual lands or public/communal lands to be forested. “Current land tenure and rights enabling determination of the owner of forestry CER” should be confirmed for the project activity (UNFCCC 2012a). Project promoter had to clarify legal title to the land. In addition, when submitting a PDD for validation, the project promoter should have established the control over forestation for at least two-thirds of the total area of land planned for an A/R CDM project, and the project promoter should provide evidence of control at the latest by the time of submitting the first monitoring report for verification (UNFCCC 2012a). In order to satisfy the requirements of clarifying land tenure, the developing countries needed to address issues such as: “(1) poor registry systems to clarify the legal land tenure rights in an effective manner; (2) lack of institutional capacity to put in place the institutional instruments that help increase land tenure rights security; and (3) conflicts over land tenure rights in the project area” (WB 2011b). The requirements relating to land rights of A/R CDM would result in prohibiting smallholders to participate in A/R CDM project, because in particular, large numbers of smallholders had no clear land rights.

(4) Estimation of carbon stocks change

The carbon pool of land consisted of above-ground biomass, below-ground biomass, litter, dead wood and soil organic carbon (UNFCCC 2005b). For the A/R CDM project, above- and below-ground biomass where large volume of carbon accumulation was expected by forestation was usually selected as a target to sequestrate carbon. The method for estimating carbon stocks of the baseline was specified in an individual A/R CDM methodology; however, it was a basic requirement to determine the baseline in a transparent and conservative manner regarding the choice of approaches, assumptions, methodologies, parameters, data sources, key factors and additionality, and taking into account uncertainty (ibid.). A reliable estimation of existing carbon stocks and carbon stocks change during the project period in the targeted land took time and cost, since the data relating to carbon stocks of woody perennials were little in the developing countries. In the evaluation of the net anthropogenic GHG removals by sinks, UNFCCC decided that Annex I Parties should use the IPCC good practice guidance for LULUCF (IPCC-GPG-LULUCF) for preparing annual inventories under the Convention (UNFCCC 2003). The IPCC-GPG-LULUCF also should be used as the technical basis for A/R CDM projects. The IPCC-GPG-LULUCF expected to use local values of the host country. This requirement of data collection has become a burden for project promoter. Limited data collected by a survey tended to cause overestimation of carbon stocks change during the project period compared with actual vegetation, whereby net anthropogenic GHG removal resulted in underestimation. For A/R CDM projects, fast-growing tree species, e.g. exotic species used for timber or firewood like *Eucalyptus sp.*, pine, acacia, or teak, were usually selected as main tree species, in order to promote carbon stocks increase in the forested area. In some cases the introduction of native species was promoted to ensure biodiversity. Since native trees were slow growing in general, negative returns in the financial aspect of the project will be caused if these species were included. Besides, the data of native species necessary for forestation was fewer than exotic species, and the forest management process, including seedling production, planting method, survival rate in situ, was usually unknown for them. The investment risk for forestation using native trees for A/R CDM was higher than using fast-growing exotic species.

(5) Estimation of leakage

Leakage was defined as “the net change of anthropogenic emissions by sources of GHGs which occurs outside the project boundary, and which is measurable and attributable to the CDM project activity” (UNFCCC 2005b). An A/R CDM project was required not only to estimate leakage appropriately but also to be designed in such a manner as to minimize leakage (ibid.). Leakage of an A/R CDM project was caused by displacement of conventional land use to outside the project boundary due to forestation activity on the original land. For example, if forestation was conducted in arable land, crop cultivation could not be continued; the alternative arable land outside of the planted area was ensured by converting conventional land use (e.g. forest) to arable land. In this case, the carbon stocks lost in the previous forest outside of the planted area caused by changing to arable land were regarded as leakage. If cattle grazing was conducted in the grassland to be forested by an A/R CDM project, this land could not be used for grazing after forestation, therefore the cattle would be displaced to other grassland outside the project area, where overgrazing would occur due to grazing of additional cattle. In this case, overgrazing increased GHG emission from the land and caused leakage. In order to estimate the leakage, field survey was required, and led to an increase in transaction costs.

(6) Assessment of environmental impact

Project promoter should carry out an analysis of the environmental impacts of an A/R CDM project, including impacts on biodiversity, natural ecosystems, and impacts outside the project boundary. If the environmental impacts of the A/R CDM project were assumed significant, the project promoter should carry out an environmental impact assessment in accordance with the host Party's procedures (UNFCCC 2012a). There was "medium confidence that approximately 20 to 30 % of species assessed so far are likely to be at increased risk of extinction if increases in global average warming exceeded 1.5 to 2.5°C (relative to 1980-1999)" (IPCC 2008). This means that there is a tendency that animals and plants observed familiarly could increasingly be classified as rare species, and the scope of environmental impact assessment required for an A/R CDM project would be expanded. If a rare species was found, the project promoter must undertake a detailed environmental study, countermeasures to mitigate the impact, and procedures to obtain approval for the assessment and countermeasure plan of the project from the host country. These activities increased cost, took time, and resulted in delay of the project, thus led to an increase of investment risk. In addition, the project promoter should carry out an analysis of major socio-economic impacts of the A/R CDM project, including impacts outside the project boundary (UNFCCC 2012a).

(7) Procedures of DNA

A promoter of CDM projects needed to receive "written approval of voluntary participation from the DNA of each Party involved, including confirmation by the host Party that the project activity assisted it in achieving sustainable development" (UNFCCC 2001b). Some of DNAs of the developing countries did not fully understand the procedures for CDM projects, and they were unable to advance the appropriate approval procedures by coordinating the national institutions relating to the CDM project. Curnow stated that “a track record revealing irregularity or frequent delay in the issuances of approval can discourage investment” in CDM projects (Curnow 2009). The lack of competency in DNA would lead to an increase of transaction cost.

Simplification of methodologies and procedures for A/R CDM projects should be promoted to alleviate difficulties, however, simplified modalities and procedures were only established for small-scale A/R CDM projects in 2005 (UNFCCC 2005c). Simplified methodology for small-scale A/R CDM projects aimed to reduce transaction cost by simplifying the procedures of A/R CDM projects, while its application was limited to the project planned for low income communities and individuals, where the definition of low income was determined by a host Party. The upper limit of GHG removals by sinks of small-scale A/R CDM projects was less than 8,000 tCO_2/ year initially, and increased in 2007 to less than 16,000 tCO_2/ year. Actually, what has been simplified did not significantly reduce the transaction costs. Locatelli et al. demonstrated that the probability of realizing a small-scale A/R CDM project was less than 2 % if the transaction cost reduction was 20 or 50 % (Locatelli et al. 2006). On the contrary, “the rule requiring the involvement of low income communities can further increase transaction costs” where capacity of DNA was low (WB 2011b).

2.3 Registered A/R CDM projects

For the location of CDM projects in general, there was a strong bias towards 5 countries (China, India, Brazil, Viet Nam, and Mexico), where concentrated more than 80 % of CDM projects. On the contrary, the regional distribution of the registered A/R CDM projects, in spite of the small number of projects and very few issuance of CER, was well balanced as indicated that within 94 A/R CDM projects, 34 were located in Asia, 28 in Africa, 28 in Latin America, and 4 in Europe. The regional distribution of A/R CDM projects is shown in Table 2.1. The number of the projects validated for registration, including ones not registered with the CDM EB, was 94, whereas that of the projects succeeded in registration was 45.

A/R CDM projects were divided into large-scale and small-scale projects by a threshold of 16,000 tCO_2/ year of GHG removal. For small-scale A/R CDM projects, a simplified methodology was used. Of the registered A/R CDM projects, the number of large-scale projects was 27 (60 %), and that of small-scale ones was 18 (40 %). Expected GHG removal of large-scale A/R CDM projects was from 179,242 tCO_2/ year to 4,896 tCO_2/ year, where the difference of maximum and minimum was 36 times. The GHG removal of small-scale A/R CDM projects ranged between 11,596 tCO_2/ year and 621 tCO_2/ year, a difference of 19 times. Percentage in number of small-scale A/R CDM projects contributing to social forestry involving smallholders or farmer groups was higher than that of large-scale projects.

Table 2.1. A/R CDM projects registered within CDM EB until the end of the first commitment period

Region	Country	Number of projects validated for registration	Number of registered projects
Asia	China	11	3
	India	16	8
	Indonesia	2	
	Lao People's Democratic Republic	1	
	Philippines	2	
	Republic of Korea	1	1
	Viet Nam	1	1
Subtotal	7	34	13
Africa	Democratic Republic of the Congo	3	1
	Ethiopia	1	1
	Ghana	1	
	Kenya	10	3
	Madagascar	1	
	Mali	1	
	Niger	1	
	Senegal	1	1
	Uganda	7	6
	United Republic of Tanzania	2	
Subtotal	10	28	12
Europe	Albania	1	1
	Republic of Moldova	3	2
Subtotal	2	4	3
Latin America	Argentina	2	1
	Bolivia	2	1
	Brazil	6	3
	Chile	3	2
	Colombia	10	5
	Costa Rica	1	1
	Nicaragua	1	1
	Paraguay	1	1
	Peru	1	1
	Uruguay	1	1
Subtotal	10	28	17
Total	29	94	45

Source) Author compiled from UNFCCC data (UNFCCC 2013a).

Of the project participants, the WB through BCF and so forth has participated in 22 registered projects (21 by BCF, and 1 by Prototype Carbon Fund of WB), which corresponded to 49 % of the registered A/R CDM projects. BCF belongs to the WB Carbon Finance Unit, and is a public-private initiative mobilizing resources for pioneering projects that sequester or conserve carbon in forest- and agro-ecosystems, mitigate climate change, and improve local livelihoods (WB 2011b). BCF’s contribution to promote globally A/R CDM projects, having low profitability and various difficulties, was high. Except for the WB, 28 private companies, 11 governmental agencies, 7 public institutions, and 5 NGOs participated in A/R CDM projects (containing duplicates). Taking into account that 16 projects were supported by public institution of host country against 17 projects where private entity was a project promoter, the participation percentage of public institution was very high, while CDM projects were usually implemented by private sector.

The forested area ranged between 75 ha and 20,290 ha, and the difference in sequestrated amounts of CO_2 into the trees was also large. Sequestrated CO_2 amount per unit area varied widely between 1.5 tCO_2/ ha/ year and 37.6 tCO_2/ ha/ year. On average, 11.2 tCO_2/ ha/ year was for large-scale projects and 17.5 tCO_2/ ha/ year for small-scale projects.

For tenure of land to be forested, almost all the public land or communal land was planned for social forestry that local residents were involved in. Industrial forestation projects, relatively larger than projects with people’s participation, were aimed at the land owned by a project promoter or private companies. The land use rights and ownership of land for 45 A/R CDM registered projects are indicated in Table 2.2.

Table 2.2. Attribution of rights for land use and land ownership in the registered A/R CDM projects

The holder of the right to land use or land ownership	Number of projects[a]
Farmer	19
Government	18
Communal land	18
Private company	16
Public entity	4
Total	75

Source) Author compiled from UNFCCC data (UNFCCC 2013a).

[a] Since some projects included several kinds of land tenures, the total number of projects exceeded the number of registered projects (45 as shown in Table 2.1).

Projects targeting national or public land and communal land were concentrated in former planned economy countries (Albania, China, Moldova, and Vietnam) and in Africa (Ethiopia, Kenya, Uganda, and Senegal). The projects to forest lands where private companies had the legal land rights were common in Latin America. In Kenya and Uganda, project promoters formulated several small-scale A/R CDM projects in degraded state-owned land and adjacent communal land in one targeted region with the participation of the resident community groups. Of planned small-scale A/R CDM projects, all 5 projects in Uganda, as well as 3 out of 7 projects in Kenya were registered.

The A/R CDM projects formulated in the lands provided by individual farmers totaled 18, of which all of the 7 registered projects in India were to forest the lands where farmers had rights to land use or ownership. The CER of the registered "Reforestation of severely degraded landmass in Khammam District of Andhra Pradesh, India under the ITC social forestry project" was acquired by applying CDM methodology extensively to the lands of smallholders (UNFCCC 2009b). A private company (ITC) supported by the state government and NGOs undertook this project, which targeted 3,398 households in 3,070 ha in Andhra Pradesh. The rights of ownership of land and CER were confirmed by written agreement between the project promoter and participant farmers in every A/R CDM project.

Tree species have been selected from exotic species of fast-growing and appropriate timber production, as well as from useful native species. Considering the impact on the ecosystem, the combined planting of native and exotic species was conducted in many A/R CDM projects (25 projects). On the other hand, the number of registered A/R CDM projects with only exotic species and only native species was 13 and 8 respectively. According to the monitoring reports of the A/R CDM projects having obtained CER, the carbon accumulation of exotic species ensured a large amount of carbon credit, while carbon accumulation by native species was small, except for the project of “Humbo Ethiopia assisted natural regeneration project” which achieved carbon stocks increase through adopting natural regeneration of native species by means of farmers' participation (UNFCCC 2012b).

AF was planned in 8 projects, of which 4 projects included silvopastral activities (see Annex 2). No A/R CDM project including AF obtained CER during the first commitment period.

Of the A/R CDM projects including AF, 5 projects were located in Latin America, where the potential for AF was high. Registered AF activities included: (1) intercropping between tree rows (Paraguay, Democratic Republic of the Congo, and Costa Rica); and (2) benefitting from fruit or sap such as coffee (Colombia), fruit trees (India), *Hevea brasiliensis* (Colombia). A Bolivian project was registered with silvopastral activities. The projects developed in Colombia (2 projects) and in Costa Rica had both AF and silvopastral systems.

Of three projects not in Latin America, the project in the Democratic Republic of the Congo intended to plant acacia with high density of 1,111 trees/ ha used for firewood, and to integrate with the production of cassava (UNFCCC 2011a). This system was a promising countermeasure to firewood shortage, with its target to achieve stable production of cassava and firewood by rotating acacia production in 5-20 year cycles.

The remaining two projects were located in India. The one Indian project was the first A/R CDM project planned to earn carbon credit from fruit tree plantation, covering 12,347 parcels owned by 8,107 smallholders, and planting mango, cashew nuts, and tamarind (UNFCCC 2011b). The other was a project to plant *Eucalyptus sp.* incorporating with food crops. The planting density of AF was usually from 100 to 600 trees/ ha, except the highest case of the A/R CDM project in the Democratic Republic of the Congo (1,111 trees/ ha) and in Bolivia (833 trees/ ha).

It was not clear in the published PDD what incentives were adopted by the project for farmers and local residents to participate in the A/R CDM project. To secure initial investment funds including incentive cost were important, because CER was issued ex-post depending on the emission reduction determined by monitoring activity after implementation of the project. During the project process, the project promoter must find prospective carbon buyers who were interested in the project, and sign with the buyers on emission reduction purchase agreement (ERPA) to secure the funds. At any phase of the project cycle, there was the option of establishing an ERPA between interested credit buyers and project promoters (Morera et al. 2007). In order to obtain the initial capital investment, engagement of early ERPA was required. The forestation project, belonging to voluntary carbon market for smallholders, adopted the method to pay compensation to farmers and groups within a certain period of time on the basis of a contract, according to the number of living trees after planting or the monitoring results regularly carried out on the plantation (Peskett et al. 2010).

For the A/R CDM projects supported by BCF, once project preparation and due diligence were completed, the negotiation and signing of ERPA occurred before issuance of CER (WB 2011b). The BCF bought carbon credits from forestry projects for prices of USD 3.75-4.35/ tCO_2 (Morera et al. 2007), determined by the individual project. For example, the registered A/R CDM project in Ethiopia anticipated carbon revenues from the BCF in the order of USD 726,000 for the first 165,000 tCO_2 over the initial ten years of the project according to the ERPA, and the first carbon revenue was received by the project, a sum of about USD 34,000 (Brown et al. 2011). The fact that the project in Ethiopia was launched in 2007 and first CER was issued in 2012 (UNFCCC 2012b) indicated that the payment from BCF before issuance of CER was beneficial, however, a large part of the cost for forestation of 2,728 ha and operation of project including incentives to farmers for 5 years would have to be provided by the project promoter.

Six A/R CDM projects, all of which were large-scale projects, acquired CER. The issuance amount of CER has fluctuated significantly from 46 % to 167 % against the amount indicated in the registered PDDs of those projects, except 3 projects whose issued CER was similar to the planned CER. As for tree species, two projects introduced only *Eucalyptus sp.* (India and Brazil), and 2 other projects accounted for a major portion of *Eucalyptus sp.* (India and China). Consequently, the CER from *Eucalyptus sp.* accounted for more than 80 % of the entire issued CER amount.

Five out of 6 A/R CDM projects that successfully acquired CER were assisted by the BCF. This demonstrated that CER acquisition from A/R CDM projects was difficult without support of BCF or a large company. There were 5 A/R CDM projects involving smallholders which acquired CER. The financial data were confidential in all the projects, thus it was unclear whether these project obtained net carbon benefit. In addition, 2 projects (both in India) were for forestation of farmers' own lands, while 3 projects for planting in public or communal land and one project in the land owned by a private company. There was no A/R CDM project involving smallholders and having acquired CER in LACs, where the potentiality to forest farmers' own lands was high.

Table 2.3 summarizes the A/R CDM projects acquired CER.

Table 2.3. A/R CDM projects with issuance of forestry CER by 31 December 2012

	Project title	Tree species	Actual CER (tCO_2)	Planned CER (tCO_2)	Ratio of actual to planned CER (%)
1	Facilitating reforestation for Guangxi watershed management in Pearl River Basin (China)	*Pinus massoniana, Liquidambar formosana, Cunninghamia lanceolata, Eucalyptus sp. (E.grandis × E.urophylla), P. massoniana, Quercus griffithii, Schima. Superba*	131,964	262,981	50
2	Moldova soil conservation project (Moldova)	*Robinia pseudoacacia, Populus sp*, Oak (*Quercus sp.*), Poplar (*Populus alba, P. nigra*)	851,911	972,161	88
3	Reforestation of severely degraded landmass in Khammam District of Andhra Pradesh, India under ITC social forestry project (India)	*Eucalyptus tereticornis Smith, Eucalyptus camaldulensis Dhen*	404,897	402,533	101
4	Humbo Ethiopia assisted natural regeneration project (Ethiopia)	*Acacia spp., Aningeria adolfifericii, Podocarpus facutus, Olea africana, Cordia africana, Croton macrostachytus, Erthrina spp., Ficus spp, Hagenia abyssinica, etc.*	73,339	69,868	105
5	Reforestation as renewable source of wood supplies for industrial use in Brazil (Brazil)	*Eucalyptus urophyla, Eucalyptus grandis, Eucalyptus camaldulensis*	4,072,355	2,440,967	167
6	Improving rural livelihoods through carbon sequestration by adopting environment friendly technology based agroforestry practices (India)	*E. grandis, E. camaldulensis, Hybridization from Eucalyptus teriticornis* & *E. camaldulensis, Casuarina equisetifolia*	79,811	175,011	46
	Total		5,614,277	4,323,521	130

Source) Author compiled from UNFCCC data (UNFCCC 2013a).

2.4 Discussion

The difficulties for A/R CDM projects were derived from the characteristics of forest (non-permanence, uncertainty, and long period) together with complex constraints of methodologies and procedures common to CDM projects in general. They were found in demonstration of additionality, land eligibility, clarification of land rights/CER rights, estimation of carbon stocks change (baseline, project scenario, and leakage), assessment of environmental and socio-economic impacts, and procedures of DNA.

If the project targeted communal lands or smallholders’ lands in low income rural area, the difficulties would be enhanced due to the necessity to organize community members and smallholders through workshops and awareness raising activities, in order to ensure a certain scale of an A/R CDM project.

It was assumed that the disadvantages derived from the characteristics of forest led to low carbon price, difficulty of estimating the correct amount of increase in carbon stocks and led to increase of long-term risks of A/R CDM projects. Difficulties of A/R CDM projects relating to methodologies and procedures could be divided into technical and institutional difficulties. Technical difficulties could be solved by data collection, on-site studies and experiments, if a project promoter was able to provide sufficient fund for the work, and importantly had time margin. On the other hand, institutional difficulties, such as organization of farmers, clarification of land rights/CER rights, procedures of DNA would be more expensive and time-consuming to solve than technical difficulties, and had risk to fail the project itself.

Simplifying the mechanism of A/R CDM projects has been considered. The simplified modalities and procedures for small-scale A/R CDM projects were established in 2005 (UNFCCC 2005c). Since the authorized simplified methodology had almost no effect to reduce transaction cost, the further simplification of the methodology has been examined continuously (WB 2011b). Excessive simplification, however, had risk to result in doubtful GHG emission removals and lower the reliability of the issued carbon credit, “as this would violate the principle of environmental integrity of the treaty” (Locatelli et al. 2006). Simplification of technical difficulties led to simplifying the way to estimate the increase of carbon stocks, and was likely to have risk to reduce the reliability of the estimates of carbon stocks. It was assumed that there was a certain limit to simplify technical difficulties. On the other hand, the institutional difficulties were irrelevant to the estimation of carbon stocks change, and the effect of streamlining institutional aspects of methodologies and procedures would be large. The strategies to mitigate and simplify the above difficulties of A/R CDM projects especially which targeted SSFs would be discussed along with analyzing the A/R CDM project in Paraguay in Chapter 3.

The number of A/R CDM projects registered with the CDM EB was 45 at the end of the first commitment period of KP, of which 6 projects have been issued CER. On the results of analyzing these registered projects, the current state of A/R CDM projects was summarized as follows:

(1) The distribution of the projects was balanced regionally in the world;
(2) The share of large-scale projects in the number of projects was 60 %, while the remaining was small-scale projects. Small-scale projects were often targeting farmers or farmer groups, and having high social value;
(3) The participation percentage of public institutions was high;
(4) For tenure of land to be forested, almost all the public land and communal land were planned for social forestry that local residents were involved in;
(5) Exotic species of fast-growing and appropriate timber production were preferred to native species;
(6) Percentage of AF was high in Latin America, but not outstanding in general;

(7) As an incentive for forestation, payment to farmers or farmer groups by project promoter was likely prevalent;
(8) The support from the BCF was so large that majority of A/R CDM projects successfully acquired CER were assisted by the BCF.

The locations of A/R CDM projects were not biased to Asia, such as other CDM projects, but implemented a lot in Latin America and Africa. It could be said that the establishment of A/R CDM projects was possible in every region in the world if there was enough external support, albeit the technical and institutional difficulties. Plantation type of exotic monocultures were found in large-scale A/R CDM projects conducted by private companies, while forestation project targeting smallholders and rural communities with native species often combining with exotic ones were usually found in small-scale A/R CDM projects.

A/R CDM projects were expected to offer great benefit to rural communities (Peskett et al. 2010) as A/R CDM projects were possible to be implemented in low income rural area. Practically, high participation rate of public institutions, that provided public land for forestation, proved that they put an importance on social benefit that would be brought by A/R CDM projects.

The possibility of direct payment to the participant farmers was also expected, though it was not clear in the published PDD what incentives were adopted by the project for farmers and local residents to participate in the A/R CDM project. Looking at past cases and the projects supported by the BCF, compensation for forestation was paid to farmers or farmer groups under certain conditions (Jindal et al. 2008, van Kooten 2009, Palmer et al. 2009, Paskett et al. 2010, WB 2011b, Shames 2013, etc.). It was assumed that payment to farmers or farmer groups as an incentive for forestation was common, if taking into account that many PDDs of A/R CDM projects mentioned employment increase as an effect of the project.

For forestation, exotic species with fast-growing, pest-resistant, and withstanding adverse natural conditions, in particular *Eucalyptus sp.* were likely introduced in many A/R CDM projects in order to earn CER efficiently. There was a concern that the introduction of A/R CDM projects would promote vast monoculture forestation with exotic species by large companies (Boyd et al. 2005). In fact, more than 80 % of the issued CER was from *Eucalyptus sp*. The CER from the A/R CDM projects planned to introduce only native species has yet been issued, though 8 projects of such type were registered with the CDM EB.

AF was regarded as an essential component of global efforts to enhance rural livelihoods, and A/R CDM methodology for AF was developed. However, the number of registered A/R CDM projects including AF was only eight, which planned to introduce not only intercropping food crops but also a variety of fruit trees, coffee, rubber, and animal husbandry. Regionally, the percentage of AF in the registered A/R CDM projects was high in Latin America where forestation was implemented in private lands. Carbon accumulation per hectare was poor due to low density of trees, and no CER was issued to A/R CDM projects specified to AF except in Paraguay till the end of August 2013.

The A/R CDM projects were unattractive for the private sector due to disadvantages derived from forest characteristics. On the other hand, the BCF promoted the formulation of A/R CDM projects with the active support of developing country governments.

Even if registered with the CDM EB as A/R CDM projects, the projects which could actually obtain CER were few. Only 6 projects succeeded in issuance of CER by the end of 2012, of which 5 projects were assisted by the BCF, and one was promoted by a large Indian company. This demonstrated that the role of public finance or large companies to earn CER from A/R CDM projects, which was the objective of CDM projects, was high due to low profitability of A/R CDM projects. The CDM projects which could not acquire CERs implied that the investment fund and time used for establishing the project was wasted.

The registered A/R CDM projects indicated that the expectation for A/R CDM projects to contribute to improvement of livelihood in rural area was high in the developing countries as well as experts engaged in forestation or rural development, but practically a few projects could acquire CER only if they were supported by the BCF or a large company. The farmers including smallholders obtained benefit from the A/R CDM project as a payment to their forestation activity especially in the project supported by the BCP based on ERPA.

It was suggested that formulating an A/R CDM project and obtaining CER would be more difficult than emission reduction CDM projects because of characteristics of forest. The institutional requirements would be more difficult to solve than technical requirements, and would be crucial to develop an A/R CDM project. However, the results of literature survey did not make clear how to solve the requirements for establishing an A/R CDM project involving smallholders in the South America, where organizing plenty of smallholders in the direction to foresting their lands or communal lands would be difficult.

The economic feasibility of an A/R CDM project was unclear. There were no actual data on cost to establish an A/R CDM project involving smallholders, though the work to formulate and monitor an A/R CDM project by organizing plenty of farmers was assumed to require high cost and long time. Possibility to reduce transaction cost was suggested but unclear while the possibility would be small due to the inefficiency of organizing smallholders and collecting data from them, if comparing to an industrial plantation A/R CDM project. As for carbon benefit, there was no data of actual forestry CER value because those data were few due to few issuance of forestry CER (only 6 projects at the end of 2012) and confidentiality of project promoters.

The analysis on the sustainable development of an A/R CDM project was not based on the survey but just described in PDDs. There were no data on the sustainability of A/R CDM forestation conducted by smallholders. AF in an A/R CDM project was not evaluated from the point of sustainable development and smallholders' livelihood, though it was recommended for smallholders' land use and a part of an A/R CDM project.

3 An A/R CDM project involving small-scale farmers in Paraguay

3.1 Introduction

An A/R CDM project involving SSFs in the Department of Paraguarí, the sixth lowest income area in Paraguay (DGEEC 2004a), was developed by the Japan International Research Center for Agricultural Sciences (JIRCAS). Prior to starting the A/R CDM project, a soil conservation project was conducted in the same project area as the A/R CDM project for 3 years from 2004-2006. The A/R CDM project started from 2006.

The SSFs comprised 83.5 percent of the total households in Paraguay. Land suitable for forestation and AF was widely distributed in the holdings of SSFs due to soil erosion and degradation of soil fertility caused by long-term inappropriate land management. In addition, while Paraguay is a party to the KP, capacity development had been delayed, so there had been no record of registered CDM projects in Paraguay in 2006. JIRCAS, the project promoter, established a joint research agreement with the Ministry of Agriculture and Livestock (MAG), the National University of Asunción (UNA), the National Institute of Forestry (INFONA), and related institutes to implement the study on an A/R CDM project.

The A/R CDM project was implemented in 2 Districts (San Roque González de Santa Cruz and Acahay) in the Department of Paraguarí whose percentage of the population below the poverty line was in the sixth highest in Paraguay. The project targeted SSFs, including several middle-scale farmers who requested inclusion in the project to forest their unused land. In the project area, a number of community workshops were held, followed by counting farmers who wanted to participate in forestation. The project promoter undertook the formulation of an A/R CDM project, supply of seedlings, monitoring, and acquisition of carbon credit.

The main process of the A/R CDM project in Paraguay is shown as follows:

(1) Activities prior to formulation of an A/R CDM project (2004-2006);
(2) Formulation and implementation of the A/R CDM project (2006-2009);
(3) Pre-monitoring activities (2010-2011);
(4) Monitoring activities and acquisition of carbon credit (2012-2013).

The project promoter solved the issues associated with the A/R CDM project at each stage. In the process to solve additionality, one of the main requirements for formulating an A/R CDM project, the project promoter proved that forestation would not proceed without carbon credit, because there was no available financing system or subsidy policy for forestation in Paraguay.

The project promoter obtained registration with the CDM EB as "Reforestation of croplands and grasslands in low income communities of Paraguarí Department, Paraguay" in September 2009. The A/R CDM was planned in more than 16 communities in 2 districts to forest 215 ha with 240 parcels, of which 52 ha with 83 parcels were for AF. The number of participant farmers was 167 of which 80 farmers for AF. Tree species were *Eucalyptus grandis* (61.2 ha), *Eucalyptus* *camaldulensis* (80.8 ha), and *Grevillea robusta* (20.8 ha for monoculture, 52.3 ha for AF). The issuance of carbon credit was achieved in August 2013 for 81.5 ha (see 3-6 in detail).

The A/R CDM project in Paraguay proved that CER could be issued to an A/R CDM project involving smallholders by solving all the difficulties relating to A/R CDM. The way how to solve the difficulties, as an issue one set for the study, was shown below according to the implementation process of the project.

3.2 Methods and study area

3.2.1 Method for the activities prior to an A/R CDM project

The project area was selected based on the opinion of MAG from low income Departments where soil erosion and deterioration of soil fertility were ongoing. The project targeted SSFs. Sixteen communities for the project were selected based on the information of MAG and the result of the first community workshops held in the recommended communities. All the communities were not organized and a person who was trusted by the community members should have been selected by vote as a leader farmer in the second meetings (J-Green 2007a).

At first, the A/R CDM project in Paraguay started as a verification study for rural development focused on prevention measures of soil erosion and degradation. After selecting the communities, the following activities were implemented: (1) awareness raising for sustainable use of natural resources; (2) improvement of conventional conservation techniques highly acceptable to farmers; (3) capacity development of farmers; and (4) establishment of community development plan to solve community issues.

In parallel with the community activities, a demonstration farm was set up in San Roque González de Santa Cruz, where soil conservation measures, soil fertility restoration techniques, and forestation and AF techniques, which were doable and acceptable to farmers, were introduced and demonstrated. Part of the land owned by the leader farmer was selected as a farmer verification field in all the communities.

After awareness raising activities, the project proceeded to the next stage which was to prepare a farm plan (plan integral de la finca or PIF). The farm plan was a plan prepared by the farmers that envisaged appropriate land use change, farm management methods, and activities to improve livelihood.

A soil conservation contest was held on the practical performance of various conservation measures and on the degree of understanding about the significance of the conservation work learned from project activities between community farmer groups in the project area.

After compiling farm plans, workshops to analyze community issues and to create a community development plan were held in every community. The project promoter proposed a micro project for farmer groups (micro proyecto grupal or MIG) as feasible activities to improve livelihood in communities. The MIG covered the training cost, and required payment of 30 % of the cost from farmers, when equipment and materials were purchased for MIG activities. The participant farmers accepted the idea of MIG.

Subsequently the project advanced to the stage to raise awareness of farmers through creating a new farm plan, which planned more sophisticated income improvement activities utilizing external funds. As an external fund, micro credit (MIC) was tried. The project promoter conducted experimental pilot MIC activities, such as broiler poultry, community retail store, small-scale irrigation, onion production, to identify problems and ways to resolve them.

3.2.2 Methods for formulation and implementation of an A/R CDM project

The farmers' needs of forestation were confirmed in farm plans which were prepared by participant farmers. In 2006, forestation of farmers' seriously degraded lands through an A/R CDM project was considered. As a step to examine possibility of an A/R CDM project, the project area was checked by the existing forest distribution map of Eastern Paraguay (in 1945, 1965-68, 1984-85, and 1991) for proving land eligibility of an A/R CDM project that the lands planned to be forested were "lands that did not contain forest on 31 December 1989".

Workshops relating to forestation were held in 16 communities, followed by a survey of all the farmers who requested forestation to confirm their intention and to determine their specific site for forestation by GPS/GIS.

The project in Paraguay set a threshold scale to implement the A/R CDM project at more than 300 ha. If the survey on farmers confirmed that requested forestation area was more than 300 ha in the project area, procedures to formulate an A/R CDM project commenced with a baseline survey in farmers' land planned to be forested. The small-scale A/R CDM methodology "AR-AMS0001 version 04.1", which was applicable to forestation of cropland and grassland, was selected to the project as the methodology best suited to the project area.

Tree species for forestation were determined from the information collected from INFONA, UNA, and farmers in the project area on farmers' preference, easiness of management, marketability, etc. Nursery was established in the demonstration farm.

For estimating baseline carbon stocks, a forest survey in the proposed forestation parcels was conducted. The method of the forest survey is shown as follows:

(1) Sampling scale was 10 % of proposed forestation parcels (around 280 in total at the time in 2007) ;
(2) Forest survey was conducted in sampled parcels to count all the trees, confirm tree species, and measure diameter at breast height (DBH) and tree height;
(3) For trees less than 10cm of DBH, measurement of trees was not necessary but the number and species of trees were examined [2];

[2] Within Mercosur countries consisting of Argentina, Uruguay, Paraguay, Brazil, and Venezuela, the trees with less than 10cm of DBH are regarded as saplings, and excluded from stem volume calculation.

(4) The survey results were classified into grassland and cropland to calculate biomass;
(5) Rare plants and animals were recorded, if observed;
(6) The above-ground baseline carbon stocks were calculated by allometric equation based on DBH and tree height adopted by UNA;
(7) The below-ground baseline carbon stocks were calculated by multiplying above-ground baseline carbon stocks with the default value of root to shoot ratio shown in the IPCC-GPG-LULUCF.

Allometric equation used for the calculation of above-ground baseline carbon stocks is shown below.

$$SV=\pi * (DBH/100/2)^2 * H * FF$$

Where,
DBH: Diameter at breast height (cm)
H: Height (m)
FF: Form factor (native tree: 0.775, palm: 0.800)

For estimating growth scenario, the existing literature provided the volume table for *E. camaldulensis* and *E. grandis*, whereas *Grevillea robusta* had no data in Paraguay. The growth scenario of *Grevillea robusta* was determined by analyzing rings collected from sampled trees in a monoculture forest of *Grevillea robusta* with more than 30 years old, which were found and harvested in the Department of Paraguarí.

The period of the A/R CDM project was set for 20 years from the longest growth period of *Grevillea robusta* to harvest in the projected species. The growth period of *Eucalyptus sp.* to harvest was set for 12 years after planting, and 8 years remained before the end of the 20 year project period. *Eucalyptus sp.* grew during these 8 years by regeneration from coppicing. Experimental results from Brazil were adopted to estimate the growth scenario of regeneration of *Eucalyptus sp.* (Matsubara et al. 2009).

It was not possible to obtain the basic wood density of tree species in Paraguay, thus the UNA was entrusted to conduct basic wood density experiments for *Eucalyptus sp.* and *Grevillea robusta* by using harvested sample trees.

The methodology AR-AMS0001 version 04.1 required that the total cropland area should be less than 50 % of the A/R CDM project area. Also, the number of displaced grazing animals should be less than 50 % of the average grazing capacity of the project area. Grazing capacity was calculated from Annex D of AR-AMS0001 version 04.1 as follows.

$$GC = ANPP * 1000 / (DMI * 365)$$

Where,

GC: Grazing capacity (head/ ha)

ANPP: Above-ground net primary productivity in tonnes dry biomass (td.m./ ha/ year)

DMI: Daily dry matter intake per grazing animal (kg d.m./ head/ day)

According to the methodology AR-AMS0001 version 04.1, the default value of ANPP and DMI could be calculated as 8.2 td.m./ ha/ year and 25.5 kg d.m./ head/ day respectively.

As for additionality, according to AR-AMS0001 version 04.1, the project promoter should provide an explanation to show that the project activity would not have occurred anyway due to at least one of the following barriers:

(1) Investment barriers, other than economic/ financial barriers
(2) Institutional barriers
(3) Technological barriers
(4) Barriers relating to local tradition
(5) Barriers due to prevailing practice
(6) Barriers due to local ecological conditions

As for estimate of ex-ante and ex-post actual net GHG removals by sinks, total carbon stocks in biomass at time N(t) in the project area were calculated as follows:

$$N_{(t)} = \sum_{i}^{I} (N_{A(t)i} + N_{B(t)i}) * A_i$$

$N_{A(t)i} = T_{(t)i} * 0.5$

$N_{B(t)i} = T_{(t)} * R * 0.5$

$T_{(t)i} = SV_{(t)i} * BEF * WD$

Where,

$N_{A(t)i}$: Carbon stocks in above-ground biomass at time *t* and stratum *i* under the project scenario (tC/ ha)

$N_{B(t)i}$: Carbon stocks in below-ground biomass at time *t* and stratum *i* under the project scenario (tC/ ha)

A_i : Project area of stratum *i* (ha)

$T_{(t)i}$: Above-ground biomass at time *t* under the project scenario (td.m./ ha)

R: Root to shoot ratio (td.m./ td.m.)

0.5: Carbon fraction of dry matter (tC/ td.m.)

$SV_{(t)i}$: Stem volume at time *t* and stratum *i* for the project scenario (m^3/ ha)

WD: Basic wood density (td.m./ m^3)

BEF: Biomass expansion factor (over bark) from stem to total above-ground biomass (dimensionless)

For this equation, the growth scenario of tree species was applied to estimate stem volume (SV), and the results of sampling surveys to basic wood density (WD). The default value of IPCC-GPG-LULUCF was applied to BEF and R.

As for estimate of leakage, the methodology indicated that if the area of the cropland within the project boundary was displaced due to project activity being higher than 10 % of the total project area, or the number of grazing animals displaced was higher than 10 % of the average grazing capacity of the project area, and both of them were less than or equal to 50 %, then the entire leakage should be equal to 15 % of the ex-ante actual net GHG removals by sinks (UNFCCC 2007c). In order to confirm the requirement for application of 15 % default value of leakage, a livestock survey relating to number of cattle grazed in grassland where planned to be forested was conducted for all the farmers who requested forestation in their grassland.

3.2.3 Methods for pre-monitoring activities

Pre-monitoring was conducted for the purpose of confirming the validity of the monitoring plan described in the PDD of the project. As the first activity of pre-monitoring, confirmation of the locations of the forested parcels by reading GPS coordinates started from the second half of 2009 to the beginning of 2010, and was completed by mapping by GIS. In the pre-monitoring, the project promoter visited all the participant farmers (167) to confirm the growth of forested parcels and to interview them about forest management and issues relating to leakage (displacement of cropping activity and cattle grazing from the forested parcel). The information obtained from the visit was compiled. The classification of reasons for cancellation was prepared for 36 cancelled farmers.

For the forest survey in the pre-monitoring, permanent sample plots in each stratum were established. From IPCC-GPG-LULUCF, the permanent sample parcels were selected randomly to satisfy 13 % of the number of parcels of each stratum (IPCC 2003). Additionally, the project promoter selected at least 3 parcels per stratum, which resulted in increase of number of sample parcels.

The permanent sample plots with 400 m^2 (20 m × 20 m) were established within the permanent sample parcels located more than 10 m inside from the boundary of the parcels and having an average tree growth of the parcels. Concrete stakes with the head marked by yellow paint were placed at the four corners of the plots, and the location of the one of the stakes was measured by GPS.

The monitoring activity of permanent sample plots by the project promoter was conducted in July 2010. The net anthropogenic GHG removals by sinks were estimated by multiplying the average carbon stocks per ha per stratum to the forested area of stratum, which was tentatively calculated by monitoring results of GPS coordinates.

For the verification of the monitoring, the methodology required that the monitored carbon stocks should ensure precision level of ±10 % of the mean at a 90 % confidence level. In order to satisfy this precise level of monitoring, the number of sample plots was calculated according to the methodological tool of A/R CDM (UNFCCC 2010). The equation to calculate the number of sample plots required for estimation of biomass stocks is shown as follows.

$$n = \frac{N * t_{VAL}{}^2 * \left(\sum w_i * s_i\right)^2}{N * E^2 + t_{VAL}{}^2 * \left(\sum w_i * s_i{}^2\right)}$$

Where,

n: Number of sample plots required for estimation of biomass stocks within the project boundary (dimensionless)

N: Total number of possible sample plots within the project boundary (i.e. the sampling space or the population) (dimensionless)

t_{VAL}: Two-sided Student's t-value, at infinite degrees of freedom, for the required confidence

w_i: Relative weight of the area of stratum *i* (i.e. the area of the stratum *i* divided by the project area) (dimensionless)

s_i: Estimated standard deviation of biomass stocks in stratum *i* (td.m. or td.m./ ha)

E: Acceptable margin of error (i.e. one-half the confidence interval) in estimation of biomass stocks within the project boundary (td.m. or td.m./ ha), i.e. in the units used for s_i

i: Biomass stocks estimation strata within the project boundary

The project promoter calculated n above after estimating w_i and s_i based on the results of 35 sample plots. UNA as the third party not included in monitoring activity verified the results of the monitoring in September 2010. The comparison between the results of monitoring by the project promoter and verification by UNA was conducted to find whether the difference was less than 10%.

In the demonstration farm established in the project area, 3 tree species to be distributed to farmers were planted in experimental plots by the leader farmers as a part of the practical training in June 2007. The strata of these plots corresponded to S1 (*E. grandis* planted in 2007), S3 (*E. camaldulensis* in 2007), and S7 (*G. robusta* with AF planted in 2007). Tree survey on tree height and DBH on all planted trees in the demonstration farm began in June 2008, one year after planting, and measurement continued every six months.

In order to cope with the poor growth of *Eucalyptus sp.* found in the pre-monitoring, the project promoter conducted: (1) a questionnaire survey on farmers to find causes of poor growth; (2) detailed soil survey; (3) experiment to improve the growth of existing tree stands; and (4) new planting experiment to reduce poor growth.

With respect to a questionnaire survey on farmers conducted in 2010, the number of farmers who planted *Eucalyptus sp.* was 19 out of the 35 farmers having a permanent sample parcel. Two of them living in the capital, Asunción, were excluded from the survey, whereas one farmer having an excellent *Eucalyptus sp.* parcel was added to supplement the number of fine parcels.

The total number of farmers for the questionnaire survey was 18.

Trench soil surveys were conducted as a detailed soil survey on the permanent sample parcels of *Eucalyptus sp.* For the survey, one parcel from every “S” class of excellent carbon stocks (more than 10 tC/ ha), “A” of good (2-10 tC/ ha), and “B” of ordinary (1-2 tC/ ha) was selected. From “C” class of poor carbon stocks (less than 1 tC/ ha) parcels, three ones were selected. The plot of *Eucalyptus sp.* in the demonstration farm (S class), was added. All the parcels, 7 in total, belonged to 18 parcels for the questionnaire survey. A trench of 1m wide, 2m long, and 1m deep was dug in the selected parcels. Soil profile was examined in each trench, and the samples taken from each soil layer of the trenches were analyzed according to appropriate soil analysis methods.

The field test to improve the growth of *E. grandis* was planned in selected farmer’s forested parcels with *E. grandis*. The selected parcels were 2 with code number A3F5-1 of permanent sample parcel with poor growth, and ATG1-1 where a specific part of poor growth was extended in the parcel. The method of test was to apply green manure and cattle dung in each parcel. The test plots were established in existing *Eucalyptus sp.* forest with 3 small experimental plots shown as follows: (1) application of green manure and cattle dung; (2) application of green manure; and (3) control without treatment. If a dry spell continued, the growth of trees planted in sandy soil would be inhibited by the stress due to lack of moisture. Green manure such as pigeon pea (*Cajanus cajan*), which had long roots to penetrate hardpan and produced plenty of biomass to increase organic matter in the soil, was considered to be effective for this situation. After applying green manure and cattle dung in December 2010, the heights of *E. grandis*, grown in the plots, were measured every 3 months. *E. grandis* in two parcels were planted in 2007. The number of rows was 10 in A3F5-1, and 8 in ATG1-1.

Besides the test to improve the growth of planted trees, experiments to ensure the growth of *Eucalyptus sp.* from the planting was undertaken. This experiment included four plots shown as follows: (1) conventional method of planting (hole depth of 15 cm); (2) green manure + 15 cm depth; (3) green manure + 30 cm depth; and (4) green manure + cattle dung + 30 cm depth. The depth of 30 cm was assumed enough to destroy hardpan which was formed at 15 to 20 cm under surface. The plots for the experiment were prepared in the new demonstration farm on the land owned by the Ministry of Education and Culture (MEC) of Paraguay, in the District of Quiindy (hereinafter called as the ‘Quiindy demonstration farm’) where the land was left unused. The project promoter started to use this land for experiments from September 2010. After preparing the land and set experimental plots, the seedlings were planted in September 2010. After weeding, the plots planned for use of green manure were planted with three rows of *Canavalia ensiformis*, and two rows of *Cajanus cajan* which was intercropped between rows of *Canavalia ensiformis*. The height of whole trees in the experimental plots was measured every 3 months from January 2011.

3.2.4 Methods for Monitoring activities

Taking into account the results of the pre-monitoring, the formal monitoring activities of the project started in 2012. The monitoring activities were focused on the parcels with carbon stocks more than 10 tC/ ha, that was determined on the set value of baseline carbon stocks (11.88 tC/ ha in cropland and 10.32 tC/ ha in grassland) in PDD. In the formal monitoring, the permanent rectangular sample plots with 20 trees as a minimum number (Vallejo et al, 2011) were established in an excellent and representative part of the whole parcels to be monitored to satisfy accuracy of 10 % precision level with 90 % confidence. The method to establish 400 m^2 of permanent plots established in the pre-monitoring was cancelled.

The third party not committed to the monitoring work should conduct the verification of monitoring activities or quality control and quality assurance (QC/ QA) activity. The QC/ QA work on the monitoring results of the project was conducted by UNA and INFONA. Considering the importance of timely verification, the time schedule was arranged so that the QC/QA work by UNA could be implemented a week later finishing the monitoring work by the project promoter. The QC/QA work by INFONA followed a week after UNA finished the work. The QC/QA team from UNA and INFONA confirmed the predetermined sample size of monitoring activities shown as below:

(1) Location and area of forested parcels (10 %);
(2) Carbon stocks in permanent sample plots (20 %);
(3) Land tenure of forested parcels (10 %);
(4) Leakage (20 %).

Survey of carbon stocks on entire parcels to be monitored was conducted from July to August 2012. The QC/ QA work on the monitoring results finished around 2 weeks after the completion of carbon stocks monitoring. The method of measuring carbon stocks was as follows:

(1) Establish permanent sample plots with 20 trees (5 lines × 4 rows) in the forest more than 10 m inside the boundary, and attach a numbering tag to each tree. Missing plants were counted and included within 20 trees;
(2) Record the coordinates of the first trees in the sample plots by GPS;
(3) Measure height and DBH of trees in order of the tag number;
(4) Measure distance between the center of the first tree and that of the tree at the end of the corner in two directions, and calculate the control area of the plot;
(5) Calculate stem volume, above-ground biomass, below-ground biomass, then convert to carbon stocks by each tree.

The carbon stocks were determined by the following equation:

$$P_{(t)} = \sum_{i=1}^{I} (P_{A(t)i} + P_{B(t)i}) * A_i * (44/12)$$

Where,

$P_{(t)}$: Carbon stocks within the project boundary at time *t* achieved by the project activity (tCO_2)

$P_{A(t)i}$: Carbon stocks in above-ground biomass at time *t* of stratum *i* achieved by the project activity during the monitoring interval (tC/ ha)

$P_{B(t)i}$: Carbon stocks in below-ground biomass at time *t* of stratum *i* achieved by the project activity during the monitoring interval (tC/ ha)

A_i: Project activity area of stratum *i* (ha)

i: Stratum *i* (I = total number of strata)

The project promoter established permanent sample plots in the entire parcels. Therefore the classification of parcels into stratum became insignificant except for tree species which had unique characteristics. Compared to the stratum in PDD, the stratum *i* in the above equation was changed to only tree species (*E. grandis*, *E. camaldulensis*, and *Grevillea robusta*) in the monitoring. $P_{A(t)i}$ was calculated as follows:

$$P_{A(t),i} = \sum_{j=1}^{m} \sum_{k=1}^{n} SV_{i,j,k} * (1/AP_j * 10000) * BEF_i * WD_i * CF$$

Where,

$SV_{i,j,k}$: Stem volume of stratum *i*, permanent sample plot *j*, and tree *k* (m^3)

AP_j: Area of permanent sample plot *j* (m^2)

BEF_i : Biomass expansion factor (over bark) from stem to total above-ground biomass of stratum *i* (dimensionless)

WD_i : Basic wood density of stratum *i* (t d.m./m^3)

CF: Carbon fraction of dry matter (0.5) (t C/t d.m.)

n: Number of trees in permanent sample plot (≦ 20)

m: Number of permanent sample plot

$SV_{i,j,k}$ was calculated from allometric equations developed by the project according to the methodological tool (UNFCCC 2011c). The allometric equation for each species was determined by selecting more than 10 trees over a wide range, felling, dividing the tree into sections, measuring length and diameter of sections, and determining stem volume. The allometric equation was adjusted to satisfy the rule that the mean of the measured tree biomass should be greater than the mean of predicted tree biomass, and the *p* value returned by the t-test should be less than 0.20.

The carbon stocks ($SV_{i,\ j}$) per hectare of the stratum *i*, and permanent sample plot *j* were calculated as follows:

$$SV_{i,j} = \sum_{k=1}^{n} SV_{i,j,k} / AP_j * 10000$$

The below-ground carbon stocks were calculated as follows:

$$P_{B(t),i)} = P_{A(t),i} * R_i$$

Where,

R_i: Root to shoot ratio of stratum *i* (dimensionless)

The biomass expansion factor (1.5) and root to shoot ratio (0.26-0.45) were determined by the default value of IPCC-GPG-LULUCF (IPCC 2003). Basic wood density of each species (0.528-0.650 t/ m^3) was determined by experimental results of UNA.

3.2.5 Study area

Located to the southeast of the capital of Asunción, the Department of Paraguarí was settled in early Paraguay's history and developed for agriculture and livestock. The Department covered an area of 870,500 ha, and accounted for 2.1 % of the country. The population of about 220,000 people was equivalent to about 5 % of the whole country (DGEEC 2004b). Topographically, hilly areas suitable for agriculture and alluvial low land unsuitable for agriculture were intricately mixed, and farmers had generally reclaimed the hilly areas for their livelihood. The Department had a subtropical climate, whose annual average temperature was 22 degrees Celsius, annual precipitation of 1,400 to 1,600 mm, though annual variation of precipitation was large.

The Department has 17 Districts, in which the main industry was agriculture and livestock. As a result of long-term inappropriate practice of agricultural cultivation, soil erosion and soil fertility degradation has become a serious problem (Fois et al. 2004). According to the agriculture and livestock census of 2008, farmland area of the Department comprised about 680,000 ha, accounting for 2.2 % of the country. The number of farm households was about 24,000, comprising 8.2 % of the nation. The percentage of farm households with less than 20 ha (SSFs) was 90 % in the Department, larger than 83.5 % in the total number of farm households across the country (MAG 2008, see Annex 3). Land owned by SSFs in the Department accounted for 13 %, indicating the average land area per small-scale household was 4.1ha, around 1.4 ha less than the national average (5.5 ha). The major crops produced in the Department were cotton (about 27,000 ha), maize (16,000 ha), cassava (16,000 ha), poroto beans (6,000 ha), sugar cane (6,000 ha), and others including peanut, onion, and citrus. Main livestock production was cattle, but pig and poultry were also popular especially in SSFs.

In the eastern region of Paraguay, where 95 % of population lived, forest occupied 55 % accounting for 8.8 million ha in 1945, however through conversion to farmland and pasture, it decreased to 2.4 million ha, 15 % of the eastern region by 1991 (UNFCCC 2009a). At present, the percentage of forest in the eastern region was estimated to be less than 6 % of the area. The forest area of the Department was about 33,000 ha, only 0.2 % of the whole Department area. According to INFONA, a forest of 13,776 ha was changed to cropland and grassland in the Department between 1984 and 1991 (ibid.).

Two Districts, San Roque González de Santa Cruz and Acahay, were selected as a study area after reconnaissance survey and interviewing with the local responsible personnel in the Department of Paraguarí (Ohue et al. 2007).

Figure 3.1-3 shows the location of the study area.

Figure 3.1. Location of Department of Paraguarí (Shaded relief map of Paraguay. 1998)

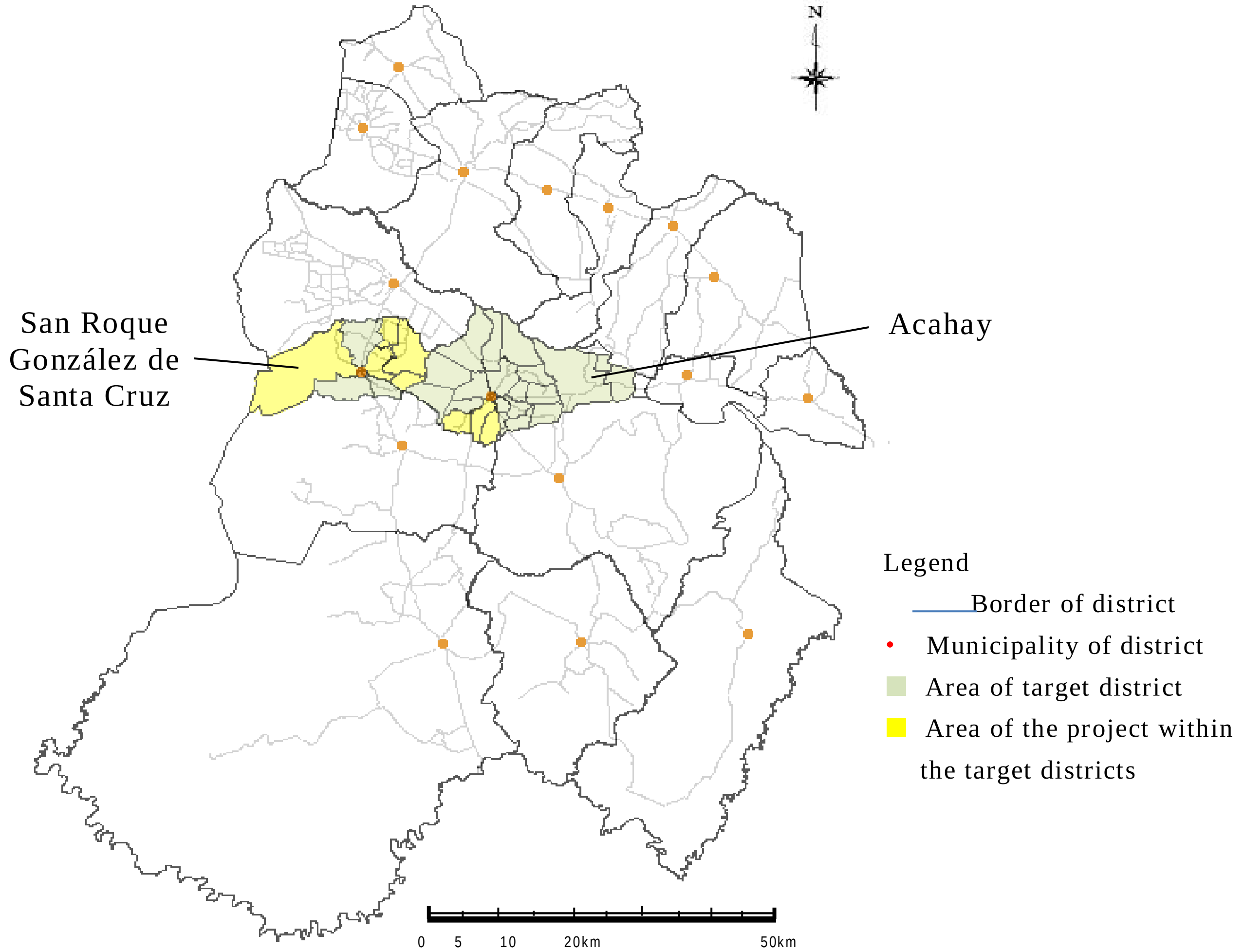

Figure 3.2. Location of San Roque González de Santa Cruz and Acahay in Department of Paraguarí (Ohue et al. 2007)

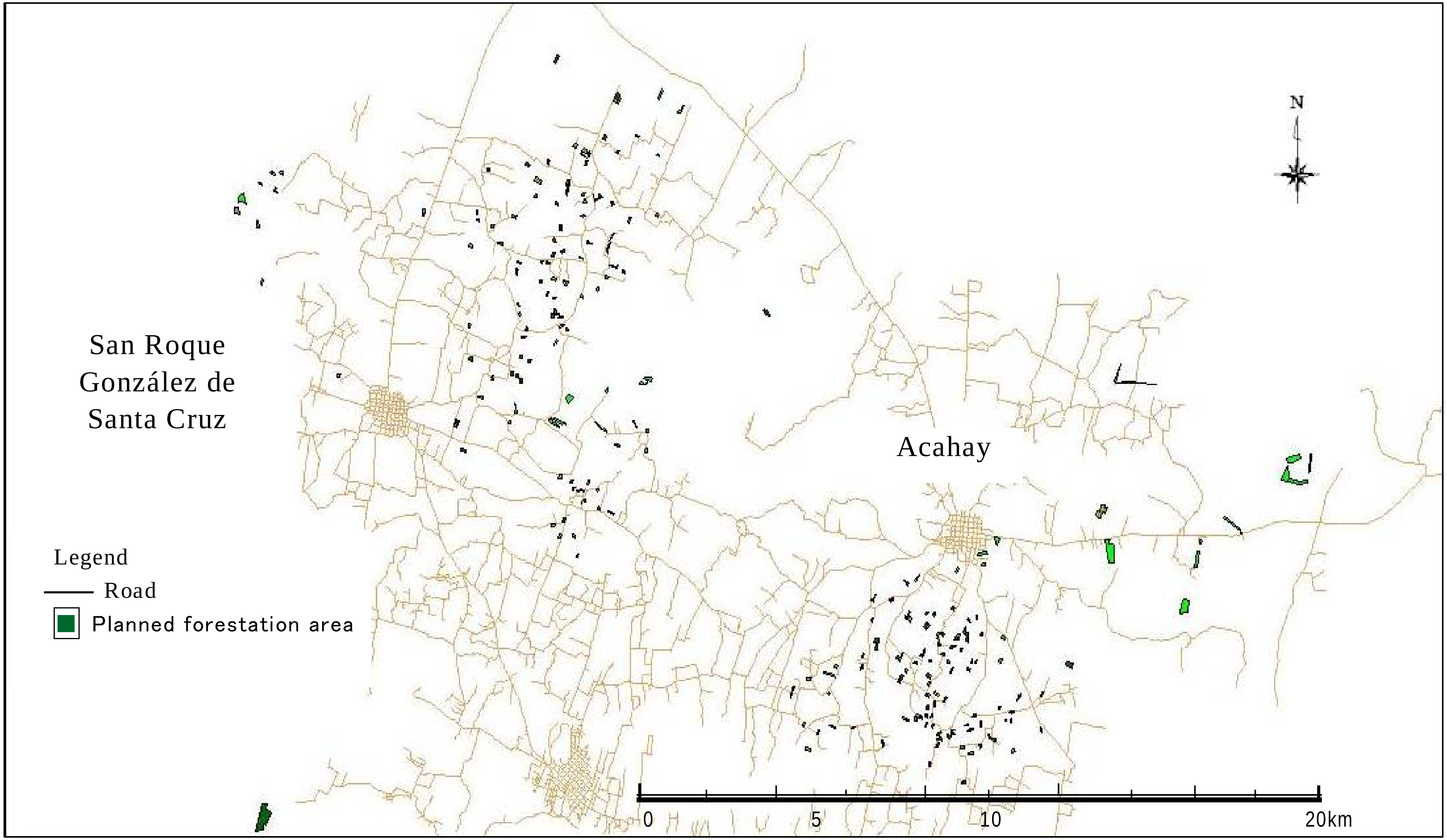

Figure 3.3. Location of parcels initially planned to be forested in 2008 (Matsubara et al. 2010)

3.3 Activities prior to formulation of an A/R CDM project

A CDM project should be formulated according to the principle of voluntary participation. When targeting a number of low income farmers in rural area, it was necessary to organize farmers in the project area, held meetings and workshops, conducted various surveys, and built trust with resident farmers in order to comply with the principle of voluntary participation, which required expense, time, and the ability of project promoter to manage and coordinate all the activities to achieve the project objective.

At first, the A/R CDM project in Paraguay started as a verification study for rural development focused on prevention measures of soil erosion and degradation in the selected communities. The community participation activities were carried out in the communities, which led to the voluntary participation of farmers in the A/R CDM project.

In community workshops, the project promoter emphasized the importance of farmers' continuing conservation activities, by indicating the causes of the deterioration of resources on the basis of examples, and by proposing simple conservation measures to prevent erosion and restore soil fertility (Ohue et al. 2007). Through holding several workshops, farmers were motivated to implement conservation activities, and understood the significance of forestation as a part of conservation, which led to voluntary forestation of their degraded land.

The flow of activities prior to formulation of an A/R CDM project is shown in Figure 3.4.

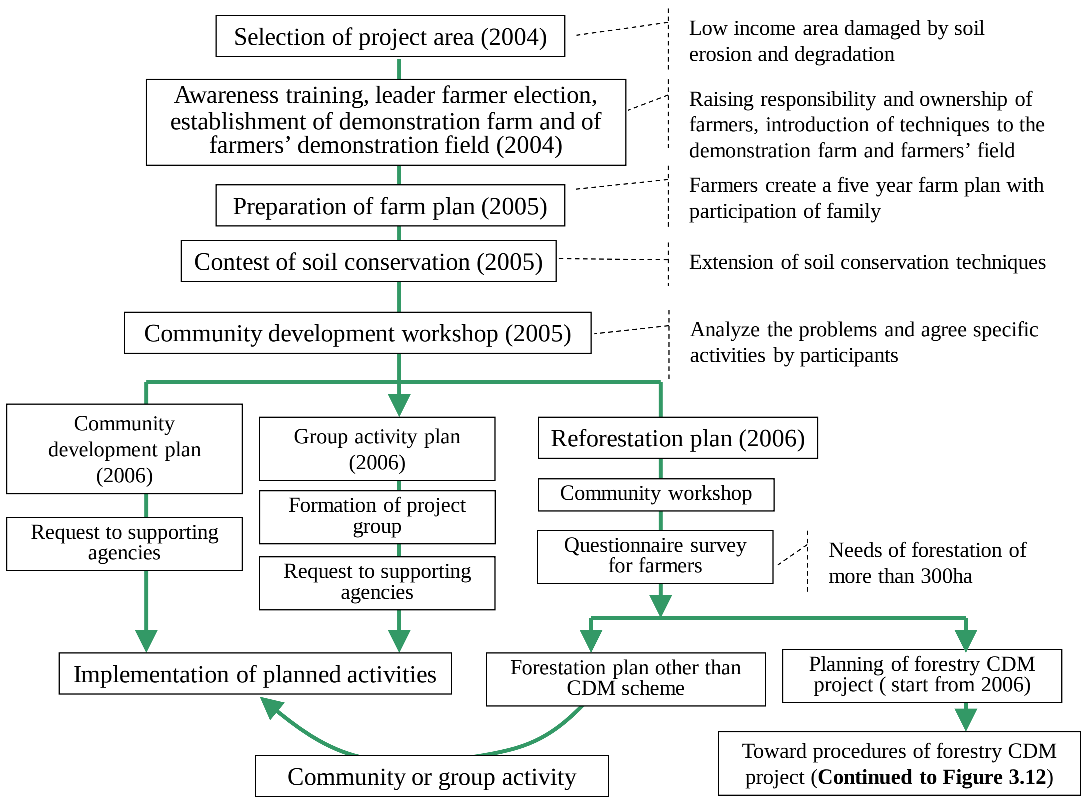

Figure 3.4. Flow of the process to the start of an A/R CDM project

Awareness training was carried out as the first project activity. In awareness training, after explanation of the purpose of the project and the mechanism of degradation of local resources, the opinions of participants about problems in the community were canvassed at a workshop held for members of the targeted communities. As a result, it was confirmed that soil erosion or soil fertility degradation has been one of the biggest problem in the community. Training was carried out for farmers to understand the significance of applying soil conservation measures, the importance of continuous activities, the applicable concrete measures for erosion control and soil fertility restoration (ibid.).

In the demonstration farm established in degraded sandy land of around 2 ha, physical land conservation measures like contour band and hedges as well as agronomic measures like cover crop and green manure were introduced and demonstrated to farmers (Figure 3.5-6). Leader farmers selected land management methods from the measures shown in the demonstration farm and applied them to the farmer verification fields. The famer verification field was usually selected in the most degraded part of the farmers' own land. By introducing soil conservation and restoration techniques in the farmer verification field, the members of the communities were expected to observe the effect of the conservation measures and apply them voluntarily to their own land (J-Green 2007a). The awareness training continued for about 5 months from June to November 2004, with the participation of around 1,000 farmers in total.

Figure 3.5. Soil erosion in the site planned to be established as a demonstration farm (Ohue et al. 2007)

Figure 3.6. Training of soil conservation for leader farmers in the demonstration farm (J-Green 2007a)

After awareness raising activities, the project promoter asked farmers to prepare a farm plan (Figure 3.7). The farm plan was a plan that the farmers envisaged appropriate land use change, farm management methods, and activities to improve livelihood. Through preparing a farm plan, farmers were expected to have a realistic idea of how to improve their farm management and sustain income generating activities. The farm plan was described as a plan to be achieved five years after its preparation. In total 172 households participated in this activity. The farm plan was finalized through discussion with family members, summarized in poster form, and presented to the workshop participants, whereby the plan was confirmed as their future plan (J-Green 2007b).

 

Figure 3.7. Preparing a farm plan (left, Ohue et al. 2007) and presentation of a farm plan at a workshop (right, Ohue et al. 2007)

A soil conservation contest was held to disseminate the conservation techniques extensively in the communities. The contest was competed between groups formed in the communities. Small prizes were awarded to excellent groups. The participant groups found it more significant to win the competition against the other farmer groups than to get a prize (ibid.). A soil conservation contest was an effective means to disseminate a variety of conservation measures to the level of farmers in a short period of time. For contest prizes, seeds of maize, green manure, and vegetables were provided. The number of competition participants increased each time, enhancing the level of techniques used for soil conservation and restoration by the participants. The participants became able to explain to others the learned conservation techniques not only on a practical level but also from a knowledge base, indicating that horizontal dissemination of information and skills was successful. The results of the soil conservation contest for the project are shown in Table 3.1.

Table 3.1 Record of soil conservation contest

Title	Duration of contest	Participant farmers (households)
First contest	April-August, 2005	124
Second contest	October 2005-February 2006	178
Third contest	April-July, 2006	224
Fourth contest	April-July, 2010	95

Source) Author compiled from Ohue et al. 2007 and Matsubara et al. 2011.

After establishing farm plans, a community development plan was established in every community through workshops to analyze community issues. The project promoter proposed MIG as feasible activities to improve livelihood in communities (Figure 3.8). MIG aimed to achieve a part of the income generation activities, which were positioned in the farm plans and the community development plans (J-Green 2007b). The life of farmers would not be improved by just applying countermeasures to resource degradation, though conservation measures were important for farmers. If farmers worked in groups, they could try new activities. For example, fish farming could be advanced if the techniques were learned as a group and practiced jointly, while individuals took ownership of the fish in their own pond. Therefore knowledge and experience would be accumulated within the group. MIG was supported by the project and implemented in farmer groups, and the minimum number of farmers was set at 5 per MIG activity. The technical training in MIG activities was open to everyone who desired to participate. The project promoter covered the training cost, however required payment of 30 % of the cost from farmers, when equipment and materials were purchased for MIG activities. The scale of MIG was commensurate with the economic conditions of farmers. Because of the system of sharing cost and the requirement to pay before starting a MIG activity, the contribution of farmers was paid by 100 %. For MIG, various fields, such as home garden, cooking, fish farming, handicrafts, crop diversification (onion, pineapple), beekeeping, and water supply, were requested. The number of MIG activities adopted in 2006 was 43 with 366 participant farmers (Ohue et al. 2007).

Figure 3.8. MIG for home garden (left, Matsubara et al. 2010) and for bee keeping (right, Matsubara et al. 2008)

Since 2007, a method to bear 30 % of the purchased materials cost was established and continued until 2010. The total number of farmers having paid 30 % of the MIG cost reached 1,378 up to November 2010. The trends for MIG participants are shown in Figure 3.9.

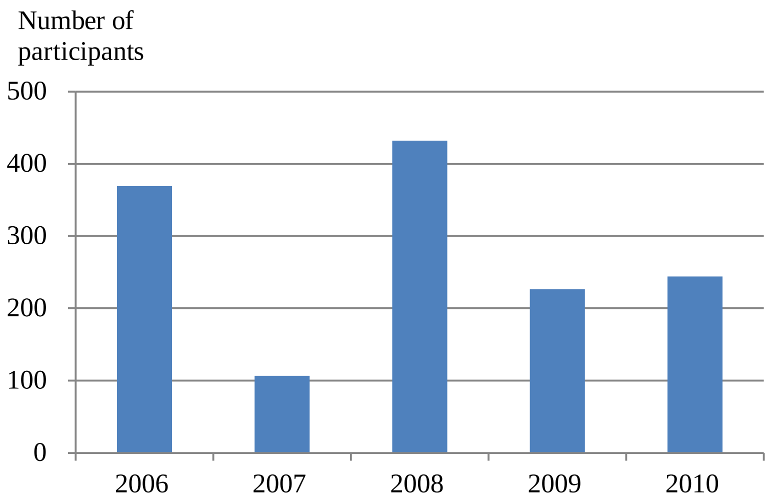

Figure 3.9. Trends in the number of participants in MIG (Matsubara et al. 2011)

MIG activities were relatively weak in 2007, when the project promoter was busy because forestation activities were in full swing, however, were activated again in 2008 when new demands such as improving cooking stoves occurred, and stabilized the number of participants at 220-240 per year thereafter. The number of participants for each MIG activity until November 2010 is shown in Figure 3.10.

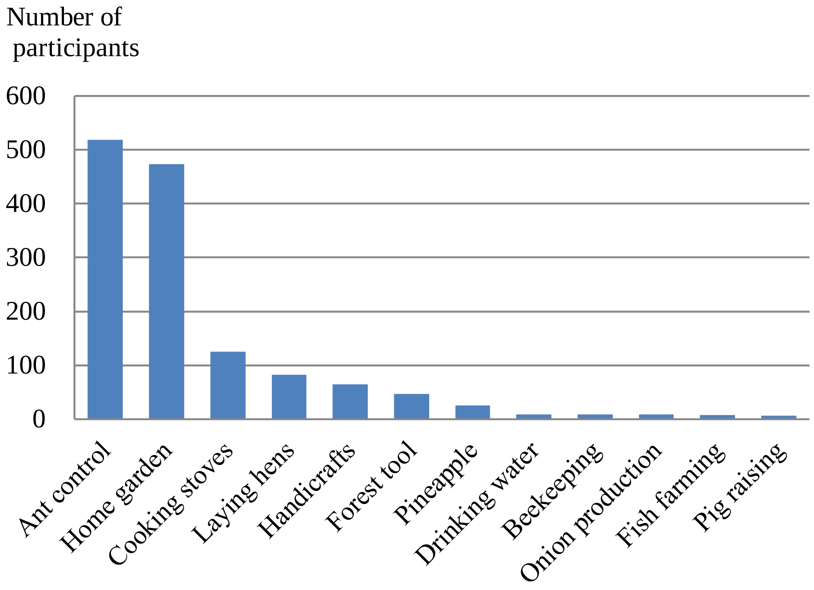

Figure 3.10. Activity-wise number of participants in MIG from 2006 to 2010 (Matsubara et al. 2011)

Ant control and home garden had an outstanding number of participants, reflecting the high needs of farmers. Especially damage by leaf cutting ants was a permanent problem that could not be solved by individual farmers but through the continuous effort of the whole community, thus it was necessary to repeat prevention activity. In the home garden, a variety of vegetables were planted usually for self-consumption, while other farmer groups expanded their production scale and sold onions and tomatoes at the market. Training costs for MIG were paid by the project, so many women participated in cooking and handicrafts training in particular.

During the progress of the project activity, there appeared farmers who realized their farm plan, and it became necessary to increase the level of project activities. The project promoter decided to raise awareness of farmers through creating a new farm plan, which planned more sophisticated income improvement activities utilizing external funds. As an external fund, MIC was considered. MIC should be introduced under the appropriate system design to ensure the two principles of poverty alleviation and sustainability of the MIC itself. The CER benefit generated from an A/R CDM project would be utilized as a source of funds for MIC. Prior to the introduction of a full-fledged MIC, the project promoter conducted experimental pilot MIC activities, such as broiler poultry, community retail store, small-scale irrigation, onion production, to identify problems and ways to resolve them (Figure 3.11). The pilot MIC was successful and repayment was smooth. However, the broilers were not sold but used for home consumption, and unfamiliar accounting work disturbed the continuity of the community retail store. Onion cultivation and small-scale irrigation were resulted in temporary activities. No activities were sustainable. Pilot MICs demonstrated the necessity of long-term capacity development of farmers to establish a micro credit mechanism that made funds rotate smoothly.

Figure 3.11. Pilot MIC; broiler poultry (left, photo by Tomio Hanano in 2009) and community retail store (right, Matsubara et al. 2011)

3.4 Formulation and implementation of an A/R CDM project

If there was no need for forestation in rural area, forestation projects including A/R CDM project would not proceed. The need for forestation in the project area was revealed in the farm plans. Many farmers had expected the effect of timber harvesting, soil conservation, and windbreak, by incorporating forestation in farm plans for the future. Then, forestation was taken up as a matter of community interest in workshops and included in the community development plans.

The project promoter determined to maximize the effect of forestation by applying the A/R CDM system, after confirming that the project area did not contain forest at the time of 31 December 1989, and satisfied the criteria of reforestation as well as afforestation in A/R CDM methodology (UNFCCC 2009a). As a methodology for A/R CDM project, small-scale methodology was selected according to the expected forestation area in the project area. Small-scale projects were “meant to assure that low income communities also benefited from projects” under the CDM (Boyd et al. 2005). From the point of view of a project promoter, it was impossible to ensure economic potential without a certain scale of forestation. The area of 8,000 tCO_2/ year, which was initially determined as the upper limit of GHG removals for small-scale A/R CDM methodology, was interpreted that the possible plantation size of the project varied from 200 to 6,000 ha (Locatelli et al. 2006).

From the estimated potential of carbon stocks increase achieved by planting fast growing *Eucalyptus sp.* and *Grevillea sp.* and rough financial analysis, the project promoter set a threshold scale of more than 300 ha to implement an A/R CDM project in Paraguay. Funding for initial investment was required, because the CER revenue would be obtained only after the amount of carbon stocks in grown trees were monitored and verified. Before obtaining the CER revenue, the project promoter must have established a forestry project as an A/R CDM project, as well as have implemented the forestry project and made the forest grow enough to ensure that appropriate amount of carbon stocks has been accumulated.

The process after confirmation that the farmers' needs of forestation exceeded 300 ha is shown in Figure 3.12.

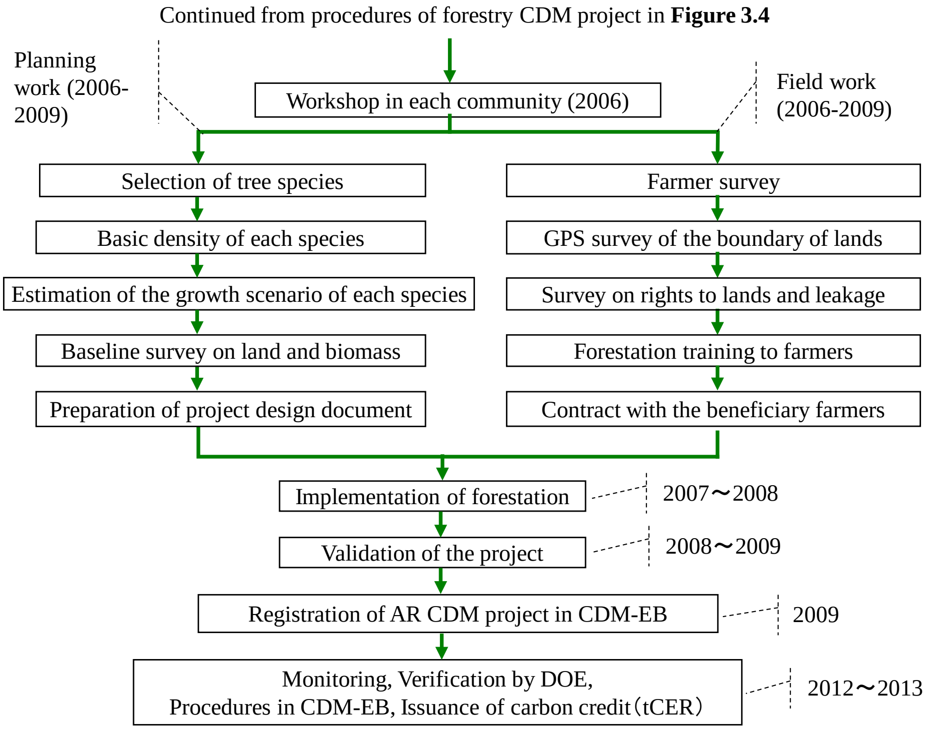

Figure 3.12. Workflow from confirmation of farmers' forestation needs to issuance of forestry CER

The needs of forestation were known because farmers placed forestation in their farm plans and community development plans. As the next step, a workshop related to forestation was held in each community, followed by a survey on farmers to find specific forestation needs. If the results of farmer survey confirmed that the requested forestation area satisfied the threshold size of 300 ha in the project area, procedures to formulate an A/R CDM project commenced with a baseline survey in farmers' requested land. If the forestation needs did not satisfy the threshold, a different form of forestation project other than an A/R CDM project should be considered. For example, supported by the project to provide techniques and materials via the MIG system (30 % cost born by farmers), a farmer group in the community would establish a nursery, produce seedlings, and distribute the seedlings to farmers who requested forestation.

In Figure 3.12, the main activities of the workflow were divided into planning work and field work. The field work included specifying the actual location of forestation, GPS survey, calculation of area through mapping by GIS, training in forestation for farmers, and signing of agreements between the project promoter and farmers. The planning work included selecting tree species, implementing experimental work relating to tree species (basic wood density, growth scenario, etc.), baseline survey for land and vegetation, preparing a PDD for an A/R CDM project. After completion of field- and planning-work, these results were compiled, and validation by DOE was undertaken.

The requested forestation area was amounted to near 300 ha of 345 farmers living in more than 16 communities. The project was accepted by not only SSFs but also by middle-scale farmers at their request. The results of the questionnaire survey are shown in Table 3.2.

Table 3.2. Survey results of the targeted communities

Items	Contents	Households, area (ha), percentage (%)
Project area	District	2 Districts
	Community	16 communities and others
	Number of farmers replied to questionnaire	345 households
Requested forestation area	Total area	292.10 ha
	Area with more than 0.5 ha[a]/ parcel (all tree species)	287.75 ha
	Area with more than 0.5 ha/ parcel (3 tree species[b])	273.17 ha
	Percentage of *Eucalyptus* to requested area	63.9 %
	Average area of forestation per parcel	0.90 ha
Interest in AF	Number of farmers interested in AF[c]	105 households
	Requested area of AF	70.3 ha
	Percentage of AF area to requested forestation area (more than o.5 ha/ parcel)	25.7 %

Source) Yokokura et al. 2007.
[a] 0.5 ha: a minimum land area of forest defined in Paraguay.
[b] 3 tree species: *Eucalyptus grandis*, *Eucalyptus camaldulensis*, and *Grevillea robusta*
[c] AF: Agroforestry

For selection of tree species, information was collected from INFONA, UNA, and farmers in the project area from the viewpoints of: (1) farmers' preferences; (2) easiness of management; (3) marketability of forest product; (4) disease resistance; and (5) possibility of AF. Based on the information collected, candidate tree species were selected (Annex 4). Among the species that were preferred or recommended, fast growing *Eucalyptus sp.*, taking about 12 years to harvest, was regarded as economically advantageous for SSFs to ensure income as soon as possible. In addition, *Eucalyptus sp.* was easy to manage, had no disease found in Paraguay, and had flowers suitable for beekeeping. The project promoter decided *Eucalyptus sp.*, especially *Eucalyptus grandis* whose annual growth was fast in Paraguay, as the main species to be introduced. *Eucalyptus camaldulensis*, able to withstand wetland condition, was selected for planting in lowland prone to flooding. As a species for AF, Paraiso gigante (*Melia azedarach*) was selected initially according to the strong request from farmers. Paraiso gigante was excluded finally, because it had a high prevalence of diseases caused by phytoplasma leading to tree withering in Paraguay.

Grevillea robusta was chosen as the tree species to replace Paraiso gigante. This species was fast growing, having good quality timber, and found no disease. *Grevillea robusta* was introduced to Paraguay more than 20 years ago, and was known to farmers. All the main species for forestation were exotic; however, the development of native species was also important from the viewpoint of biodiversity. The project produced several kinds of native tree seedlings and established an experimental parcel of AF using native tree species. More than 5,000 of these native seedlings were produced annually and were distributed to public institutes such as schools. The seedlings were also provided to the farmers who desired to plant, and to events like expositions or tree-planting ceremonies in Paraguay.

The main activities in the demonstration farm were changed from soil conservation to forestation and AF. The nursery was established at the beginning to produce seedlings covering 150 ha per year. Seeds for seedlings were provided by INFONA for *Eucalyptus sp.*, and by the National Institute of Agricultural Technology (INTA) of Argentine for *Grevillea sp.* During the planting season in 2007 and 2008, around 400,000 seedlings were provided from the nursery in the demonstration farm (Matsubara et al. 2011). The leader farmers were trained for forestation in the demonstration farm (Figure 3.13). The planted training plots were used for monoculture forestation plot (*Eucalyptus sp.*) and AF (*Grevillea sp.*). In the AF plot, annual crops such as maize, cassava and poroto beans, all of which were main food crops in the project area, perennial crops (pineapple and banana), and green manure were cultivated between rows of trees to demonstrate the growth of crops (Figure 3.14). Green manure was introduced in monoculture *Eucalyptus sp.* plots to show the fertilization effect on tree growth. In addition, the plots of AF with native trees (*Tabebuia heptaphylla, Cedrela fissilis, Peltophorum dubium*) were established for observation.

Figure 3.13. Training of leader farmers for marking planting positions (Matsubara et al. 2008)

Figure 3.14. Demonstration of agroforestry with *G. robusta* + pineapple + lupine in the demonstration farm (Matsubara et al. 2010)

The existing amount of carbon stocks accumulated in the perennial woody biomass in the proposed forestation parcels including the amount of carbon stocks increase during the project period was estimated in the baseline survey of the A/R CDM project. The project period was set at 20 years from the harvest time of *Grevillea sp.*, which had the slowest growth rate in the main tree species. In the project area, plenty of native oil palm species (*Acrocomia totai* Mart.) were present. Farmers collected fruits from the palms and sold them to a palm oil extraction factory. The farmers had no incentive to cut the palms. The majority of perennial woody biomass found in the baseline survey was from palms, which were to be left in the project activity. Initially, the project promoter excluded the biomass of palms from calculation of baseline carbon stocks, because the carbon contained in palms would be left untouched. For cropland where annual cultivation was continued and no woody perennials were found except palms, the baseline carbon stocks could be set to zero. For grassland, biomass of belowground was taken into account as a part of the baseline carbon stocks estimated by using the default value of the methodology (UNFCCC 2007c).

In the validation of March 2008, the DOE selected by the project promoter pointed out that the exclusion of palms was inappropriate; therefore, the project promoter must have added the carbon stocks in palms to the baseline carbon stocks.

The project promoter conducted a forest survey to estimate baseline carbon stocks in the requested parcels to be forested, which were randomly selected in the project area. After compiling the relevant data, the above-ground baseline carbon stocks were calculated, which were 8.02 tC/ ha in cropland and 3.66 tC/ ha in grassland. The below-ground baseline carbon stocks were calculated by multiplying above-ground baseline carbon stocks with the default value of root to shoot ratio in the IPCC table. Above- and below-ground baseline carbon stocks in cropland and grassland were 11.88 tC/ ha and 10.32 tC/ ha respectively. When excluding palm biomass, the baseline carbon stocks in cropland and grassland decreased to 1.8 tC/ ha and 6.9 tC/ ha respectively. The reason that the baseline carbon stocks in grassland were larger than in cropland when excluding palms was that grassland had less palms standing than cropland had, and the below-ground biomass of grassland was unchanged.

The growth of *E. camaldulensis*, *E. grandis*, and *Grevillea robusta* for the project period (20 years) was estimated by the growth scenario and basic density obtained from literature, experiments and on-site sampling survey.

An A/R CDM project required clarification of rights relating to ownership of trees and carbon accumulated in trees in forested area. The concept of rights to carbon was confusing to beneficiary farmers. The project promoter explained to farmers that CER was not obtained until monitoring results were verified, and it was impossible for farmers to obtain it due to no knowledge of CDM. The project promoter suggested that all the CER should be attributed to the project promoter, and the income from wood products except carbon should be owned by farmers. The project promoter also indicated that the surplus gain on the sale of CO_2 would be used for the development of communities. No farmers who participated from the beginning of the project had any doubt about this explanation. However, when the contents were documented in the form of an agreement and signatures were required, a few farmers who participated later refused to transfer the carbon rights to the project. If farmers were unable to understand the explanation, they were excluded from the project.

The main contents of the agreement with the farmers were as follows:

(1) The project promoter would provide training in forestation, seedlings based on farmers' forestation plans, support relating to MIG and rural development (included in community

development plans), and technical assistance for AF and soil conservation;

(2) Farmers would conduct planting, harvesting, and appropriate forest management including thinning and pruning;

(3) Farmers would receive benefit from wood products thinned and harvested, and crops produced in AF;

(4) The project promoter would gain carbon increased in forested parcels, and use the revenue from the carbon for the management of the forestry project;

(5) If the farmer violated the agreement, the project promoter would suspend all technical assistances;

(6) If the forested land was sold or transferred to the third party, the farmer would try to pass on the agreement to the third party.

Two copies of this agreement were prepared and retained by the project promoter and the farmer respectively after signing. Initially, in order to simplify the procedure, an agreement was prepared by each community, not individuals. A list of participants with signatures was attached to the agreement. However, at the time of validation, agreements signed between the project promoter and individual farmers were required. Thus, the project promoter needed to revisit and re-sign the agreement with farmers. Significant expense and effort were expended to obtain the agreements.

Land tenure was a sensitive issue in Paraguay. A large number of participant farmers (74 out of 167 households) had no legal rights to the land. In addition, farmers who claimed to have a land title did not dare to show it to the third party. The civil code of Paraguay ruled that people who had been occupying the land continuously for more than 20 years without interference would be able to obtain a land title in accordance with legal procedures.[3] As the first step for farmers to obtain land title, the National Institute of Rural Development of Land (Instituto Nacional de Desarrollo Rural de la Tierra or INDERT), who issued land title, would issue an "occupation certificate" which proved that the land has been occupied by a person named in the document. The occupation certificate, issued before the procedure to obtain a land title, was treated as a substitute for land title in legal proceedings in Paraguay (Matsubara et al. 2009). The project promoter obtained the occupation certificates for all the participant households from INDERT, as alternative evidences for their land ownership. In order to get an occupation certificate, the address, identification number of the owner as well as land area was required. Issuance of the occupation certificate was time-consuming, and delay caused by incorrect information from farmers occurred frequently. More effort than expected was required to get the occupation certificate. This led to a cause of delay in procedures and increase of transaction cost.

In preparing a PDD according to AR-AMS0001 version04.1, the project promoter had to satisfy all the requirements described in the methodology. The main issues which should be stated in the PDD for the A/R CDM project in Paraguay were as follows.

[3] Ley 1183/85. Codigo Civil Paraguayo y Codigo Procesal Civil.

(1) Application requirements of the methodology
(2) Explanation of additionality
(3) Estimate of actual net GHG removals by sinks
(4) Estimate of leakage
(5) Environmental impact
(6) Documents issued by DNA

As for requirements to prove that the requested project satisfied the conditions set to be applied of the methodology, the project promoter should have examined that: (1) the total cropland area was less than 50 % of the A/R CDM project area; and (2) the number of displaced grazing animals from the project boundary was less than 50 % of the average grazing capacity of the project area. For solving the first condition, the project promoter surveyed the current state of land use of all requested forestation parcels and measured the land parcels by GPS/ GIS. The area of cropland and grassland was 104.2 ha (48 %) and 111.0 ha (52 %) respectively out of 215.2 ha of the total planned area. For the second condition, the grazing capacity of the entire grassland of the project area was calculated 98 heads, when applying the default value. From the results of the field survey, 2 heads of cattle were grazed for 2 months on average in the grassland where farmers requested to be forested, indicating that 37 heads of cattle in total had potential of displacement. This displacement rate was less than 50 % of grazing capacity (49 heads). This demonstrated that the grassland of the project area was applicable to the methodology. The results of interviews with participating farmers confirmed that no cattle was displaced, because cattle was not grazed in the grassland slated for forestation due to degradation and low capacity for grazing.

As for examining additionality, the following scenarios were expected in the project area in the future.

Scenario 1: Forestation project applied to existing systems without an A/R CDM project
Scenario 2: Continuation of present land use as grassland and cropland

Barrier analysis was conducted to justify additionality. The analysis of investment, institutional and other barriers based on documentary evidence indicated that the scenario 2 was the most likely; that forestation would not proceed without the A/R CDM project, and present land use would continue (UNFCCC 2009a). This proved that an A/R CDM project was the only viable system for forestation in the project area.

For the estimate of actual net GHG removals by sinks, baseline and project carbon stocks were estimated by the results of literature survey, field surveys, and experiments in laboratory. The disadvantages derived from the characteristics of forest (non-permanence, uncertainty, and long period), tCER was selected to alleviate the risk of non-permanence. The risk of uncertainty was expected somewhat reduced by providing training to beneficiary farmers on forest management.

As for leakage, possibility to use default value of 15 % to actual net GHG removals by sinks was examined. From the survey results, the percentage of displacement of cropland area and number of cattle corresponding to grazing capacity were found higher than 10 % but lower than 50 %. Thus, the default value of 15% was found to be used in the project. Net anthropogenic GHG removals by sinks, which was calculated by actual net GHG removals by sinks minus baseline net GHG removals by sinks minus leakage, were shown in Table 3.3.

Table 3.3. Calculation of net anthropogenic GHG removals by sinks

Year	Baseline net GHG removals by sinks (tCO_2)	Actual net GHG removals by sinks (tCO_2)	Leakage (tCO_2)	Net anthropogenic GHG removals by sinks (tCO_2)	tCER[a] (tCO_2)
1	8,737	0	0	-8,737	-8,737
2	0	6,805	1,021	5,784	-2,953
3	0	16,567	2,485	14,082	11,129
4	0	3,494	524	2,970	14,099
5	0	-30	0	-30	14,069
6	0	11,140	1,671	9,469	23,538
7	0	10,519	1,578	8,941	32,479
8	0	4,530	680	3,850	36,329
9	0	2,080	312	1,768	38,097
10	0	17,798	2,670	15,128	53,225
11	0	4,802	720	4,082	57,307
12	0	-19,028	0	-19,028	38,279
13	0	-45,811	0	-45,811	-7,532
14	0	8,133	1,220	6,913	-619
15	0	16,509	2,476	14,033	13,414
16	0	4,365	655	3,710	17,124
17	0	1,099	165	934	18,058
18	0	9,014	1,352	7,662	25,720
19	0	9,696	1,454	8,242	33,962
20	0	-3,494	0	-3,494	30,468
Total	8,737	58,188	18,983	30,468[b]	

Source) UNFCCC 2009a

[a] The A/R CDM project in Paraguay chose temporary CER (tCER) for addressing non-permanence. The value of tCER in the Table shows carbon credit in each year. This does not mean that the value is acquired every year, since the tCER is issued every five years after the first issuance of tCER.

[b] The average annual GHG removal was calculated as 1,523 tCO_2/ year from this total (30,468/20).

For the environmental impact, a legal environment impact assessment was not required for the project, because only forestation projects larger than 1,000 ha in Paraguay needed an environmental impact assessment (UNFCCC 2009a). However, there were 2 tree species which were classified as endangered plant species, though those were commonly found in the project area. The project promoter asked farmers to conserve them, as well as produced plenty of native seedlings including these 2 species in its nursery, and distributed them to schools and individuals who wished to plant them (ibid). No endangered species of animals were affected by the project, because those species in the Department of Paraguarí mostly inhabited in the areas around lakes and rivers. The department of environment of local government of Paraguarí issued a document to the project which proved that there were no endangered animal species in the project area (ibid.). Adverse socio-economic effects did not occur because the participants of the project were individual farmers who forested their own land. On the contrary, forestation brought economic and environmental benefits such as ensuring firewood and timber, prevention of soil erosion and crop damage by wind.

For documents issued by DNA, the methodology required that the project promoter had to obtain two documents from the host Party shown as follows: (1) letter of approval (LoA) for the project; and (2) declaration that the project promoter targeted low income area for the forestation project. The latter requirement was only necessary for applying a small-scale A/R CDM methodology. The project promoter needed a LoA from the DNA of Annex I Party to which the project promoter belonged. If the host Party had not informed to the CDM EB the definition of forest which should be determined by the individual host Party, the project promoter had to request for the host Party to determine and inform the definition of forest of the country to the CDM EB. The DNA of Paraguay, the Secretariat of Environment (SEAM), did not have a definition of forest in 2006. The project promoter requested the DNA to decide the definition as early as possible in 2006. This was realized in 2008 by taking 1.5 years. The declaration of the low income area was also requested to SEAM in 2006 by the project promoter. The final document was issued in 2008, after spending 1.5 years from the request, due to the reason that strictly speaking, the DNA did not have the authority to decide the locations of low income communities. Issuance of the LoA for the project was also requested initially in early 2008 to the DNA. It took more than 1 year from the initial request to issue the letter with the contents corresponding to the CDM rule. It took time to finalize the DNA procedures in this way, leading to an increase of transaction costs. When receiving public funding for CDM projects from the Parties in Annex I, the DNA document from Annex I countries to prove that the fund "is not to result in diversion of ODA and is separate from and not counted towards the financial obligations of Parties included in Annex I" should be obtained (UNFCCC 2001b). The LoA issued for this project by the Japanese government was added the necessary declaration relating to public funding (UNFCCC 2013a).

It took more than one year to prepare a PDD, to clarify scientific and socio-economic matters, to conduct a baseline survey and environmental study, and to establish parcels for forestation after discussion with beneficiary farmers.

When the validation of DOE was conducted, deficiencies of PDD were pointed out. If the deficiencies found by DOE were significant, it could take a year or more to solve them by doing additional surveys. In this project, the fundamental survey on regional socio economic baseline and natural resources had been finished, because the study on soil conservation was advanced prior to the A/R CDM project. The draft of the PDD was prepared in 2007, after the project started in 2006. Followed by repeated revisions and changes, the final version of PDD was completed in February 2009, taking 2.5 years from commencement.

The on-site validation for this A/R CDM project was conducted in March, 2008. The collection of documentary evidence and modification of the PDD were followed to address the corrective action requests and clarification requests from the DOE. The important issues in the project were solved in six months; however, the delay in issuance of the government documents caused a passive situation. Approval of the Parties, including of the host Party, should be obtained before finalizing the validation by the DOE. As long as this approval document was not submitted, the DOE could not complete the validation report. The project promoter received the final version of LoA from two governments in March 2009 (Japan) and in June 2009 (Paraguay). After all, DOE requested the registration of the project with the CDM EB in June 2009. The CDM EB registered this project as an A/R CDM project in September 2009. This was the first CDM project that has been registered with the CDM EB in Paraguay.

Forestation was implemented in parallel with the surveys and procedures to formulate an A/R CDM project from 2007. Farmer training related to forestation was held first for leader farmers in June 2007, followed by training of farmers in the communities, focusing on spacing and planting, then planting activities in communities started (Figure 3.15). The training for leader farmers was continued for pruning in 2008, and thinning in 2010 (Figure 3.16).

Figure 3.15. Distribution of seedlings to farmers (Matsubara et al. 2008)

Figure 3.16. Training of thinning for leader farmers in the demonstration farm (Matsubara et al. 2012)

The requested area to be forested was changed frequently since finishing the questionnaire survey in 2006-2007, and was not fixed until July 2008. The problem was that the farmers frequently changed the location of parcels. Moreover, some of them quitted the forestation, and new farmers requested to participate in the project. According to these changes, leading to more than 10 % of initial requests, the project promoter needed to revisit the farmers and parcels, confirm the requested changes, and establish new boundaries of the parcels to be forested. It took 1.5 years to determine the boundaries of the project from the start of the baseline survey.

Among the beneficiary farmers, were included farmers residing in districts other than 2 target districts. For those farmers living outside of 2 districts, seedlings were distributed for planting, while excluded from A/R CDM project. There were farmers who planned to plant less than 0.5 ha, deviating from the definition of forest,[4] for which the project promoter distributed seedlings,

[4] The DNA of Paraguay defined forest as: (1) a minimum area of land of 0.5 ha; (2) tree crown cover of more than 25 %; (3) trees with the potential to reach a minimum height of 5 m at maturity in situ. In A/R CDM, “afforestation” was the direct human-induced forestation of land that has not been forested for a period of at least 50 years, and “reforestation” was the direct human-induced forestation on land that was forested but that has been converted to non-forested land. For the first commitment period, reforestation activities would be limited to reforestation occurring on those lands that did not contain forest on 31 December 1989. (UNFCCC 2001b)

though excluded from A/R CDM project. Further, there were some parcels where the grid of 0.5 ha was applied and the canopy rate of existing trees (especially native palms) exceeded 25 % of the Paraguayan definition. Those parcels were revisited and measured again to exclude the inappropriate part. Some communal lands were requested to forest by community members, however, no forestation of any communal lands was conducted due to lack of agreement within the community to forest the land where no private benefit could be expected.

Considering the facts above, the actual area planted by the project is shown in Table 3.4.

Table 3.4. Aggregated planted area

Classification	Planted area of *Eucalyptus sp.* (ha)	Planted area of *Grevillea robusta* (ha)	Area total (ha)	Participant farmers (households)
Requested area during the first baseline survey (2006～2007)	－	－	301.2	325
Planted area (2007～2008)	172.8	82.9	255.7	239
(1) A/R CDM project area	142.1	73.1	215.2	167
(2) Out of boundary area (located in other Districts)	25.4	－	25.4	3
(3) Area with less than 0.5 ha	5.3	9.8	15.1	69

Source) Matsubara et al. 2009

According to Table 3.4, the percentage of planned amount of forestation and number of farmers to the actual amount and number was calculated as follows:

(1) About 50 % of farmers were involved in the A/R CDM (167/ 325 households);
(2) About 85 % of the land designated for forestation was supplied seedlings (255.7/ 301.2 ha);
(3) About 70 % of the land marked for forestation was involved in the A/R CDM project (215.2/ 301.2 ha);
(4) To formulate the A/R CDM project, double the CDM farmers should have been involved (325/ 167 households), and 1.4 times the number of farmers should have been trained (239/ 167 households);
(5) As an aspect of cost, 1.4 times the area to CDM area should have been measured (301.2/ 215.2 ha), and 1.2 times the number of seedlings should have been provided (255.7/ 215.2 ha) in order to formulate the A/R CDM project.

GIS mapping was conducted for all the parcels based on the GPS data, including the excluded parcels from the A/R CDM project. Some farmers wanted to plant more than one tree species in one parcel. Since a CDM forest had to be stratified by tree species, spacing, and planting year, there was a need to subdivide the parcel according to different criteria, in order to accept the request of these farmers. After acceptance of every request from the farmers, the number of parcels amounted to 240 out of 167 farmers, of which 83 parcels (52.35 ha) were for AF with

Grevillea sp.

Planting was completed during 2007-2008, and training in forestation for farmers continued until 2010. The starting date of the A/R CDM project was set as 25 July 2007, when the distribution of seedlings to farmers began. Cool period in Paraguay, suitable for planting trees, was from April to September. The planting activities in 2007 were delayed and suffered the damage from drought. Taking advantage of this experience, efforts were made for early production and distribution of seedlings in 2008. In 2008-2009, farmers who planted the previous year were visited to monitor the growth of trees and the necessity for supplementary planting was confirmed. According to requests from farmers, additional seedlings were provided to replant parts of parcels damaged by drought.

3.5 Pre-monitoring activities

3.5.1 Project boundary

Pre-monitoring for the A/R CDM project was undertaken in 2010 to confirm the validity of the monitoring plan described in the PDD, prior to starting formal monitoring activities. The main pre-monitoring activities were: (1) confirming the locations of the forested parcels; (2) surveying trees in the permanent sample plots; and (3) finding defects of verification system if any. When problems were found in the process of the pre-monitoring, activities to solve them were conducted through additional studies and experiments.

As a result of visiting 167 beneficiary farmers, 36 households corresponding to about 20 % of the whole participant farmers were found to have problems such as no planting, planted parcel with less than 0.5 ha, and abandonment of forestation activity. Those farmers were excluded from the A/R CDM project. The number of parcels to be excluded was 55, corresponding to 23 % of the whole parcels. The reasons of cancellation are compiled in Table 3.5 (detail in Annex 5).

Table 3.5. Classification of reasons for cancellation in 2010

Reasons	Number of respondents[a]
Planting area of less than 0.5 ha	10
Damaged by drought	10
No planting	6
Migrant for work	5
Planted in a different land	5
Advanced age	3
Disease	3
Land sold	1
Communal land	1
Change tree species	1
Forest fire	1
Total	46

Source) Matsubara et al. 2011

[a] Answering more than one reason was allowed.

There were two main reasons for cancellation: (1) the size of planted area was less than 0.5 ha; and (2) the willingness of farmers to continue forestation was lost because of damaged forestation caused by drought. The number of farmers who did not plant even in a part of their parcel despite having received seedlings was 6.

Comparison of the actual situation to the plan in the PDD is shown in Table 3.6.

Table 3.6. Comparison of number of forested parcels, beneficiary farmers, and area of forestation in the pre-monitoring in 2010 with the PDD

Item	Number of parcels	Number of beneficiary farmers (households)	Area (ha)[a]	Stratum of forestation (ha)[b]							
				S1	S2	S3	S4	S5	S6	S7	S8
Plan in PDD	240	167	215.16	30.05	31.17	16.36	64.48	5.59	15.16	14.05	38.30
Cancellation	55	36	33.76	4.71	11.05	2.40	2.82	0.28	2.73	2.33	7.44
Monitoring	185	131	181.40	25.34	20.12	13.95	61.66	5.31	12.43	11.72	30.86
Cancellation rate (%)	22.92	21.56	15.69	15.68	35.44	14.69	4.37	5.01	18.00	16.58	19.42

Source) Matsubara et al. 2011

[a] The area of monitoring was calculated by subtracting cancellation area from planned area, not measured actually in situ.

[b] Stratum was established as S1: *E.grandis* planted in 2007, S2: *E.grandis* in 2008, S3: *E.camaldulensis* in 2007, S4: *E.camaldulensi*s in 2008, S5: *G.robusta* in 2007, S6: *G.robusta* in 2008, S7: *G.robusta* with AF planted in 2007, *G.robusta* with AF in 2008.

Compared to the decreased percentage of the number of parcels and beneficiaries, the decreased percentage of planted area (15.7 %) was smaller than that of farmers' number (22.9 %), which meant that the cancellations were made by less SSFs. The average area to be forested in the plan was 0.9 ha/ parcel (181.4/ 185), whereas the average area of the cancelled farmers was 0.61 ha/ parcel (33.8/ 55). If the weather conditions during planting were favorable without droughts, the results must have been different.

Table 3.6 showed the cancellation rate of planting in 2008 (S2, S4, S6, and S8) was larger than the rate of planting in 2007 (S1, S3, S5, and S7) except *E. camaldulensis*, which was planted in relatively low areas, indicating that the drought damage in 2008 was more serious than in 2007. The area selected for forestation by farmers was degraded; therefore the risk of damage from drought was quite high.

3.5.2 Estimation and verification of carbon stocks in permanent sample plots

For estimating carbon stocks in the project area, the permanent sample parcels were established. The number of permanent sample parcels was determined 35 as shown in Table 3.7.

Table 3.7. Number of parcels to be monitored

Contents	Stratum [a]								
	S1	S2	S3	S4	S5	S6	S7	S8	Total
All the parcels	56	41	17	21	9	14	29	53	240
Monitoring (% of the total)									
GPS/GIS (100%)	56	41	17	21	9	14	29	53	240
Land tenure (100%)	56	41	17	21	9	14	29	53	240
Permanent sample plot (more than 13%)	7	5	3	3	3	3	4	7	35
Leakage (30%)	17	12	5	6	3	5	9	16	73
QC/QA (% of monitoring)									
GPS/GIS (10%)	6	4	2	2	1	2	3	5	25
Permanent sample plot (20%)	1	1	1	1	1	1	1	1	8
Land tenure (10%)	6	4	2	2	1	2	3	5	25
Leakage (20%)	3	2	1	1	1	1	2	3	14

[a] Stratum was established as S1: *E.grandis* planted in 2007, S2: *E.grandis* in 2008, S3: *E.camaldulensis* in 2007, S4: *E.camaldulensis* in 2008, S5: *G.robusta* in 2007, S6: *G.robusta* in 2008, S7: *G.robusta* with AF planted in 2007, *G.robusta* with AF in 2008.

The permanent sample plots with 400 m^2 (20 m × 20 m) were set within the permanent sample parcels. The results of a preliminary carbon stocks survey in the 35 permanent sample plots, including estimated carbon stocks per area, are shown in Table 3.8.

Table 3.8. Tree survey results from the permanent plots in 2010

Stratum	Tree species/ Planting year[a]	Number of trees (individuals)	Tree height (m)	Diameter at breast height (cm)	Carbon stocks tC/ha
S1	EG/2007	47.14 (±10.88)	4.05 (±2.95)	4.08 (±2.60)	4.80 (±10.28)
S2	EG/2008	32.67 (±14.68)	2.60 (±0.76)	2.76 (±0.76)	0.47 (± 0.32)
S3	EC/2007	54.00 (±35.00)	6.34 (±4.00)	5.37 (±2.93)	13.38 (±12.14)
S4	EC/2008	50.33 (±14.57)	4.51 (±2.12)	4.08 (±1.71)	3.77 (± 3.08)
S5	GR/2007	44.33 (±23.76)	3.80 (±0.55)	5.14 (±1.46)	1.84 (± 0.36)
S6	GR/2008	20.33 (± 9.45)	1.80 (±0.24)	2.00 (±0.00)	0.08 (± 0.05)
S7	GRA/2007	15.33 (± 9.87)	2.47 (±0.29)	2.82 (±0.72)	0.20 (± 0.16)
S8	GRA/2008	20.14 (± 7.65)	2.03 (±0.56)	2.31 (±0.93)	0.15 (± 0.21)

Source) Matsubara et al. 2011

Note) Standard deviation in parentheses

[a] EG: *Eucalyptus grandis*, EC: *Eucalyptus camaldulensis*, GR: *Grevillea robusta*, GRA: *Grevillea robusta* (AF)

The comparison of the growth scenario in the PDD and the measured results according to the forestation stratum is shown in Table 3.9. As for *Eucalyptus sp.* (strata S1 to S4), the measured values of tree height and DBH were significantly smaller than those in the growth scenario (around 30 % of the growth scenario). Also, large standard deviation of the measured values indicated that the difference in tree growth among participants' parcels was large. In the strata with poor growth, the survival rate of seedlings was low. In particular the average survival rate of stratum S6 (*Grevillea sp.*) was less than 50 %.

The results of carbon stocks change estimation are shown in Table 3.10.

Table 3.9. Comparison of the tree survey results in the permanent plots with the planned growth scenario

Stratum	Growth scenario in 2010			Measured value in 2010		
	Number of trees in permanent plots	Tree height (m)	Diameter at breast height (cm)	Number of trees in permanent plots	Tree height (m)	Diameter at breast height (cm)
S1	53	14.40	13.50	47	4.05	4.08
S2	53	12.80	12.40	33	2.60	2.76
S3	53	13.40	12.50	54	6.34	5.37
S4	53	11.80	11.50	50	4.51	4.08
S5	53	1.90	2.00	44	3.80	5.14
S6	53	1.50	1.40	20	1.80	2.00
S7	20	1.80	1.80	15	2.47	2.82
S8	20	1.30	0.80	20	2.03	2.31

Source) Matsubara et al. 2011

Note) The tree height and diameter at breast height were estimated by applying form factors (*Eucalyptus sp.*: 0.475, *Grevillea robusta*: 0.440) provided by UNA.

Table 3.10. Calculation results of net anthropogenic GHG removals by sinks in the pre-monitoring in 2010

Stratum	Tree species/ planting year	Unit GHG removals (tCO_2/ha)	Area (ha)	GHG removals (tCO_2)	GHG removals in PDD (tCO_2) (reference)
S1	E.G 2007	17.61	25.44	447.92	4,914.28
S2	E.G 2008	1.71	18.63	31.88	6,356.52
S3	E.C 2007	49.05	12.13	594.95	2,634.73
S4	E.C 2008	13.82	65.22	901.57	12,949.24
S5	G.R 2007	6.75	5.06	34.15	3.91
S6	G.R 2008	0.28	12.28	3.42	4.49
S7	G.R.A 2007	0.73	10.89	7.98	2.97
S8	G.R.A 2008	0.55	32.29	17.86	0.00
Total[a]			181.94	2,039.72	26,866.14
Leakage (15 % of actual net GHG removals by sinks)			2,039.72	305.96	
Baseline GHG removals					
	Cropland	43.55	78.70	3,426.93	
	Grassland	37.83	103.24	3,905.58	
	Total/Average	40.60	181.94	7,332.52	
Net anthropogenic GHG removals by sinks[b]				-5,598.75	

Source) Matsubara et al. 2011

[a] The total equals to actual net GHG removals by sinks.

[b] Net anthropogenic GHG removals by sinks= (Actual net GHG removals by sinks) – (Baseline GHG removals – Leakage)

The typical growth deference between poor and excellent parcels of *E.grandis* is shown in Figure 3.17.

 

Figure 3.17. Difference of tree growth between farmers in the same community; the poor growth (left, code no. A3F5-1) and the excellent one (right, code no. A3F9-1) (Photo by Eiji Matsubara in 2010)

The carbon stocks increase in the project area were estimated in the pre-monitoring at about 2,040 tCO_2 or 7 % of the planned amount which was 26,866 tCO_2 in 2010 in PDD. Looking at the tree species, the carbon stocks of *Eucalyptus sp.* were less than 10 % of the planned amount, while *Grevillea sp.* stored much higher carbon than planned. The absolute amount of carbon stocks in *Grevillea sp.* were small and were considered to take more than 5 years from the present till accumulating carbon stocks above the baseline.

The causes of the large difference between the measured and the planned carbon stocks were assumed as follows:

(1) Drought in 2007 prevented timely planting;
(2) The damage from drought in the summer of 2008- 2009, which was the worst in 40 years in Paraguay, was serious;
(3) Tree growth was inhibited by weed, caused by poor management;
(4) Damage by leaf cutting ants;
(5) Supplementary planting to compensate damage, while recommended by the project promoter, was insufficient due to loss of farmers' motivation caused by the poor results of initial planting;
(6) Complying with the A/R CDM methodology, appropriate forest establishment was disturbed by the requirements of the methodology relating to minimal disturbance on lands when planting (less than 10 % of the parcel), and penalties for using fertilizer (if used, the emission from fertilizer was counted as emission increase);
(7) The growth scenario of *Eucalyptus sp.* was overestimated because the forestation plan assumed that planting would be conducted under sound forest management, not under the various restrictions of the A/R CDM methodology.

If concentrated on the excellent 20 parcels, which were selected by a rough survey of 100 m^2 plots in good looking parcels (assumed to have more than 10 tC/ ha) in the project area, the net anthropogenic GHG removals by sinks could be estimated as shown in Table 3.11.

Table 3.11. Estimates of net anthropogenic GHG removals by sinks in the 20 excellent parcels in 2010

Stratum	Tree species/ planting year	Unit GHG removals (tCO_2/ha)	Area (ha)	GHG removals (tCO_2)
S1	EG/ 2007	81.30	5.78	470.26
S2	EG/ 2008	50.72	0.56	28.41
S3	EC/ 2007	60.86	2.67	162.65
S4	EC/ 2008	68.53	30.22	2,070.96
Total			39.24	2,732.28
Leakage (15 % of actual net GHG removals by sinks)			2,732.28	409.84
Baseline GHG removals				
	Cropland	43.55	6.69	291.22
	Grassland	37.83	32.55	1,231.33
	Total/Average	40.60	39.24	1,522.56
Net anthropogenic GHG removals by sinks				799.88

Source) Matsubara et al. 2011

When excellent parcels were selected (39.24 ha), net anthropogenic GHG removals by sinks was about 800 tCO_2. The stratum S4, all of whose lands were owned by middle-scale farmers, had largest amount of carbon stocks (2,071 tCO_2) in 4 strata.

UNA as the third party has verified the results of the pre-monitoring, especially the results of forest survey, conducted by the project promoter. Not a few plots with a difference of more than ± 10 % between the pre-monitoring results and UNA's verification results were found as shown in Table 3.12.

Table 3.12. Comparison of monitoring results of the permanent sample plots between the project promoter and UNA in 2010

Level of difference	Tree height	DBH	Number of trees	Carbon stocks
Number of permanent sample plots with more than and equal to 10 % difference between the project promoter and UNA (number of parcels)	8	22	13	28
Percentage (%) of the parcels with difference more than 10 % to the number of parcels in total (35)	23	63	37	80

Source) Matsubara et al. 2012

Though the methodology stated that the error of counted tree numbers should be zero, there was 37 % inconsistency. In other words, just establishing permanent sample plots with uniform size left the possibility of misjudgment when the third party tried to reproduce the findings. Therefore, instead of managing a certain size of permanent plots, it was deemed appropriate to specify a certain number of trees by selecting trees within a grid with e.g. 4 lines to 5 rows in the plot that reflected average situation of tree growth in the parcel. The area of plot was measured and calculated as a control area of trees, depending on the actual spacing of planted trees.

For verification of the monitoring, the methodology required that the monitored carbon stocks should ensure precision level of ±10 % of the mean at a 90 % confidence level. The precision level was satisfied by setting appropriate number of sample plots determined by size of sample plot and estimated standard deviation of carbon stocks in stratum. The results of the calculated number of permanent sample plots are shown in Table 3.13.

Table 3.13. Sample size required to ensure precision

Stratum	Tree species[a]/ planting year	Forested area (ha)	Number of parcels	Average carbon stocks (tC/ ha)[b]	n value[c]
S1	EG/ 2007	25.44	45	6.53 (±12.84)	150
S2	EG/ 2008	18.63	25	0.67 (±0.47)	4
S3	EC/ 2007	12.13	13	17.87 (±15.75)	88
S4	E/C 2008	65.22	20	5.59 (±4.60)	138
S5	GR/ 2007	5.06	8	2.61 (±0.48)	1
S6	GR/ 2008	12.28	11	0.08 (±0.04)	0
S7	GRA/ 2007	10.89	23	0.30 (±0.25)	1
S8	GRA/ 2008	32.29	43	0.18 (±0.25)	4
Total/Average		181.94	188	4.23	387

Source) Matsubara et al. 2012

[a] EG: *E. grandis*, EC: *E. camaldulensis*, GR: *Grevillea robusta*, GRA: GR with AF.

[b] Standard deviation in parentheses.

[c] Number of sample plots required for estimation of biomass stocks within the project boundary.

In order to ensure the required level of precision, the project promoter should establish 387 permanent sample plots (2 times larger than the number of whole parcels) with a size of 20 m×20 m, in place of the 35 plots set for the pre-monitoring. This result was induced by the large standard deviation of carbon stocks among measured plots, due to large difference of tree growth in parcels in the project area. For obtaining carbon credit, it was found necessary to identify a relatively uniform growth part in each parcel, to establish a permanent sample plot in each parcel, and to conduct a tree survey in all the plots during formal monitoring activity.

3.5.3 Studies of *Eucalyptus sp.* in the demonstration farm and farmers' parcels

Measurement of tree height and DBH of planted trees in the demonstration farm began from June 2008, and continued for every 6 months. The measurement results of the carbon stocks change in the demonstration farm up to June 2013 are shown in Figure 3.18-20. The growth of *E. grandis* and *Grevillea robusta* in the demonstration farm exceeded the growth scenario in the PDD. The initial growth of *E. grandis* after planting was low, possibly caused by drought, thereafter the growth was improved. This indicated that appropriate management like in the demonstration farm would realize potentiality of tree species even in degraded land. The carbon stocks of *Grevillea robusta* in the demonstration farm were 12.3 tC/ ha in December 2012, which far surpassed the planned scenario (1.0 tC/ha). The high growth rate of *Grevillea robusta* was achieved by planting as AF with wider spacing than monoculture and by managing as a cropland. The growth of *E. camaldulensis* in the demonstration farm has been inhibited, because this species was intentionally planted in a plot with high groundwater level, in order to confirm its adaptability to wetland.

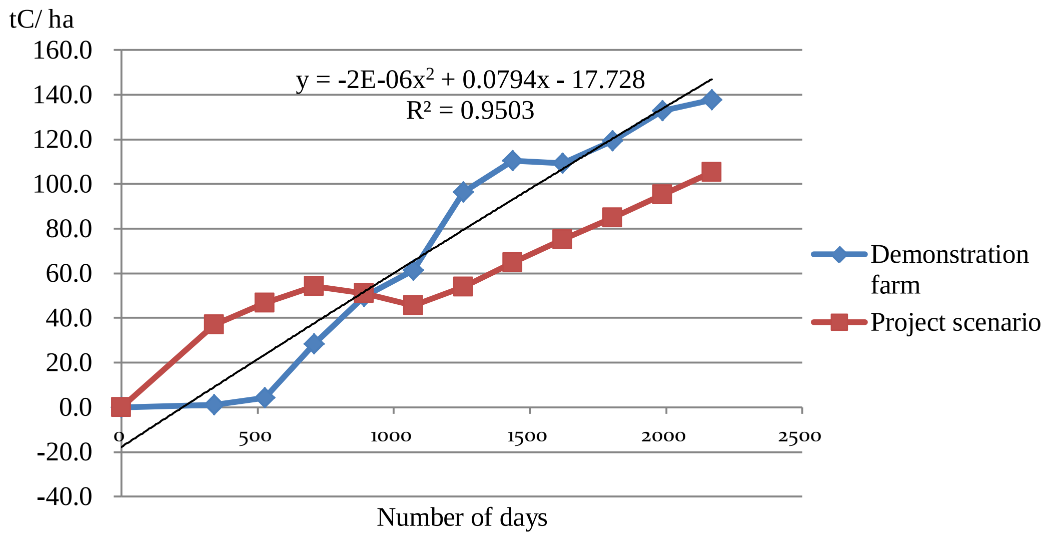

Figure 3.18. Increase of carbon stocks of *E. grandis* in the demonstration farm. Thinning was conducted at around 1,600 days after planting. In the project scenario, the thinning was planned at 1,100 days after planting.

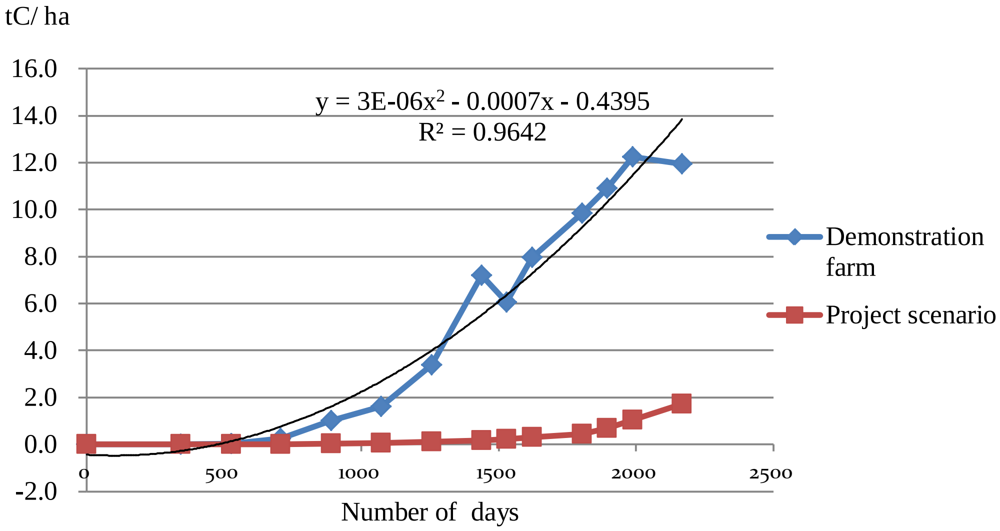

Figure 3.19. Increase of carbon stocks of *Grevillea robusta* in the demonstration farm. Thinning was conducted 2 times at around 1,500 and 2,100 days after planting. In the project scenario, the thinning was not planned for AF.

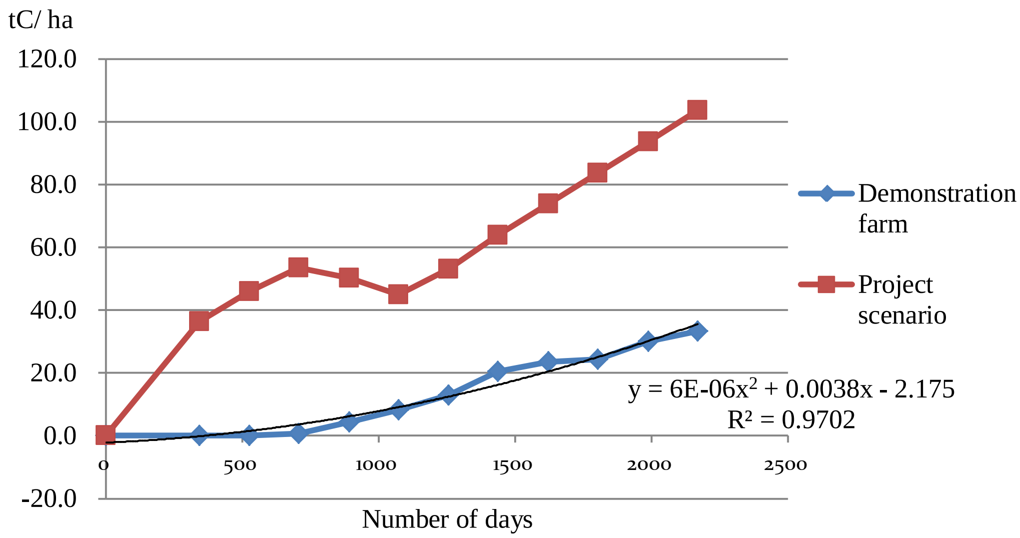

Figure 3.20. Increase of carbon stocks of *E. camaldulensis* in the demonstration farm. In the project scenario, the thinning was planned at 1,100 days after planting.

It was necessary for the project to cope with the poor growth of *Eucalyptus sp.* in the project area found in the pre-monitoring. The project promoter conducted a questionnaire survey to farmers to find causes of poor growth in 2010. The survey targeted 18 beneficiary farmers having a parcel of *Eucalyptus sp.* selected mainly from 35 farmers. The results of carbon stocks estimation in 18 parcels are shown in Table 3.14.

Table 3.14. Carbon stocks estimation for 18 parcels aimed at questionnaire survey on *Eucalyptus sp.* in 2010

	Class[a]	Tree species/ planting year	Code of parcel	Number of trees	Survival rate	Area (ha)	Tree height (m)	DBH (cm)	Unit carbon stock (tC/ha)
1	S	EG/ 2007	A20J5-1	53	1.00	1.80	10.50	9.70	28.05
2	S	EG/ 2007	A3F9-1	60	1.13	1.02	9.21	9.33	25.79
3	S	EC/ 2007	AMA7-1	89	1.68	0.50	8.90	6.76	23.90
4	S	EC/ 2007	RC12-1	54	1.02	0.64	8.38	7.35	16.14
5	A	EC/ 2008	RM10-1	52	0.98	0.81	6.16	5.15	5.61
6	A	EC/ 2008	RM17-1	64	1.21	1.33	5.26	4.97	5.48
7	A	EG/ 2007	A3F2-1	47	0.89	0.52	4.39	4.60	2.33
8	B	EG/ 2007	A3F6-1	49	0.92	0.30	3.32	3.43	1.03
9	C	EG/ 2008	Aca 6-2	39	0.74	0.28	3.28	3.49	0.83
10	C	EG/ 2008	RRC3-3	37	0.70	0.87	3.15	3.41	0.72
11	C	EG/ 2007	RRC1-1	48	0.91	0.52	2.71	3.17	0.70
12	C	EG/ 2008	RMb8-1	37	0.70	0.55	3.20	3.19	0.65
13	C	EG/ 2007	ALP5-1	45	0.85	0.43	2.31	2.44	0.33
14	C	EG/ 2008	RMb11-1	46	0.87	1.31	2.31	2.35	0.31
15	C	EG/ 2008	ATG4-1	33	0.62	0.32	2.31	2.61	0.28
16	C	EC/ 2008	RRS30-1	35	0.66	1.30	2.12	2.11	0.22
17	C	EG/ 2007	RMb4-1	26	0.49	1.79	1.93	2.08	0.12
18	C	EC/ 2007	RM6-1	19	0.36	0.40	1.73	2.00	0.09

[a] Class was divided by carbon stocks per ha. S: excellent (more than 10 tC/ ha), A: good (2-10 tC/ ha), B: ordinary (1-2 tC/ ha), C: poor (less than 1 tC/ ha)

The parcels were classified as excellent (S), good (A), ordinary (B), and poor (C) according to the amount of carbon stocks in them. The results of questionnaire survey to farmers who owned those parcels are shown in Table 3.15.

Table 3.15. Results of questionnaire survey to farmers on forest management of *Eucalyptus sp.* in 2010

Items	Contents	Class (number of respondents)				Total
		S	A	B	C	
Households		4	3	1	10	18
Weeding	Yes	4	3	1	8	16
	No				4	4
Frequency of weeding	1 time a year		1		4	5
	2 times a year	2	2		4	8
	3 times a year	2		1		3
Method of weeding	Row-like	1	1	1	2	5
	Around the tree		1	1	4	6
	Full weeding	4	1		3	8
Cattle grazing	Yes	2	2	1	8	13
	No	2	1		2	5
Start of grazing time after planting	Six months later				1	1
	1year later		2		3	5
	2 years later	2		1	3	6
Damage by cattle	Yes		1		5	6
	No	2	1	1	3	7
Use of fertilizer	Yes	1	1			2
	No	3	2	1	10	16
Cause of the growth difference within a parcel	Drought	3	2	1	6	12
	Insufficient weeding	3		1	3	7
	No tillage	2			1	3
	Damage by cattle	2	1		2	5
	Damage by ant	1	3		1	5
	Inappropriate planting	1				1
	Problem of seedlings	2	1		2	5
	Not known			1	2	3
Leaf cutting ant	No damage	1		1	6	8
	Damaged	3	3		4	10
Method of removal of ant	No action	1			1	2
	Use of pesticide	2	3		2	7
Technical support from the project	Yes	4	3	1	8	16
	No				2	2
Distribution of seedlings in proper time	Yes	3	3	1	6	13
	No	1			4	5
Timing of planting after receiving seedlings	1 day				2	2
	3 days	1	1			2
	1 week	2		1	1	4
	More than 1 week	1	2		7	10

Source) Matsubara et al. 2011

The non-weeded parcels were all owned by farmers who had poor carbon stocks in their parcels (C farmers). The three farmers of S and B weeded three times per year. Thirteen farmers practiced cattle grazing in the forested parcels, while most C farmers grazed there (8 out of 10).

Most damage from cattle grazing occurred in C farmers (5 out of 6). All C farmers did not use fertilizer, while 2 farmers (S and A farmers) did. More than half of the farmers had damage caused by leaf cutting ants. Insecticide was mainly used by S and A farmers (5 out of 7). Technical assistance from the project was provided to all farmers except two C farmers. Five farmers replied that they missed the proper planting season (April to September), because seedlings were provided untimely. In this case, four out of 5 farmers were C farmers. More than half the farmers except C farmers planted seedlings within one week after receiving seedlings. On the contrary, 7 out of 10 C farmers planted more than 2 weeks later after receiving seedlings. As for opinions of the farmers for poor growth, drought came first (12 out of 18) and followed by insufficient weeding (7 out of 18).

From the past management activities of farmers found in the survey, the causes for poor growth of *Eucalyptus sp.* at field level were assumed as follows:

(1) Impact of drought;
(2) Insufficient weeding;
(3) Early start of grazing without waiting for the growth of trees;
(4) Damage by leaf cutting ants;
(5) Damage of seedlings caused by delay of planting after receiving seedlings.

On the whole, it was a major issue to maintain the motivation of participating farmers, SSFs in particular, for the activities that required long-term commitment to realize benefits such as forest establishment.

For finding cause of low tree growth in soil of forested parcels, trench soil survey was conducted in the selected 7 parcels with *Eucalyptus sp.* The results of soil profile examination for each trench are shown in Table 3.16.

According to the soil profiles, no significant difference in the soil of the parcels was found, except the change of layer thickness affected by topographical changes. The poorest soil was found in No. 4 (AMA10-3) and No.7 (the demonstration farm) in Table 3.16, where sandy soil was more than 70 cm deep and was considered marginal for agricultural production. The difference of growth in *Eucalyptus sp.* between No.4 (class C) and No.7 (class S) was a stark contrast. Forest management caused the difference, where No.4 was not managed and on the contrary No.7 was managed very well (weeding or application of green manure). Poor growth caused by non-management was typical in the parcel of No.5 (RMb11-1). The soil in this parcel was suitable for agriculture; however, no weeding was undertaken. *Eucalyptus sp.* competed with weeds which prevented the tree growth (class C). In contrast, the difference between No.1 (A3F5-1, class C) and No.2 (A3 F6-1, class B), that were located nearby, was caused by the slope. With a slope of about 5 %, surface soil in No.1 was degraded by erosion and less covered by vegetation, whereas No.2 with about 2 % slope had less erosion and was covered by vegetation. If no hardpan was formed, *Eucalyptus sp.* of No.2 could have grown up to class A. The remaining 2 parcels (No.3 and No.6) had good growth of *Eucalyptus sp.* (class S and A). The farmers who owned these parcels replied that they managed their parcel periodically.

Table 3.16. Results of trench soil surveys in the selected parcels of *Eucalyptus sp.* in 2010

	Code of parcel	Class	Observations
1	A3F5-1	C	Top of 18 cm is sandy soil. The field has slope with more than 5 %. Hard layer is formed on the surface by erosion. Inhibition of permeability interfered growth of vegetation, even weed could not cover the surface. *Eucalyptus sp.* grows well on the top of contour band, because run-off water is retained behind the band.
2	A3 F6-1	B	Slope of the field is 2-5 %. The surface is covered with *Brachiaria sp.* Sandy soil is 21 cm deep. Hardpan is formed between 17 and 21 cm thickness, making roots of plants difficult to penetrate. The hardpan, formed by repeated plowing by farmer for a long time, prevents water and fertilizer penetration to lower layer. Gentle slope induces better growth of *Eucalyptus* than A3F5-1.
3	AMA7-1	S	Physically good. Slope of the parcel is 2 to 3 %. *Eucalyptus sp.* was planted along the contour line. The growth of trees was homogeneous. Weed control is appropriate. A model of forestation.
4	AMA10-3	C	The soil is marginal for cultivation but for forestation or grassland. Sandy soil is deep to 100 cm, with large permeability. Plant will suffer by water shortage and low growth when drought attacked. Increase of organic matter will be effective. High variation of *Eucalyptus sp.* growth. Management of the forest was poor.
5	RMb11-1	C	Slope of the parcel is around 1 %. Covered with weed. Soil is similar to that of A3F5-1. If forest was managed sufficiently, better and homogeneous stands rather than at present could be possible. Soil is suitable for agriculture.
6	RM17-1	A	Slope of the parcel is 2- 3 %. No effect of water-bearing layer of underground was observed. Trees were low and thin in the lowest part of the parcel, affected by high ground water table.
7	Demonstration farm	S	Sandy soil to 70 cm deep, and marginal for cultivation. The high growth of *Eucalyptus sp.* in the parcel was achieved by appropriate management from the planting. This parcel indicates that the growth of *Eucalyptus sp.* highly depends on forest management of land owners, except prevention of the growth by hardpan formed by long-term plowing.

Source) Matsubara et al. 2011

The results of analysis on samples taken from each soil layer of the trenches are shown in Table 3.17.

Soil was acidic or weakly acidic, and organic content was very low (less than 0.8 %). Phosphorus and potassium also was very low (less than 12 ppm and less than 0.12 cmolc/ kg respectively). The demonstration farm and RM17-1 that had excellent and good growth of *Eucalyptus sp.* contained a little more organic matter, phosphorus and potassium than others, though all of them were very low. On the other hand, AMA7-1 with excellent *Eucalyptus sp.* growth indicated no difference in soil contents with others, except a little higher potassium content than others. This suggested that the growth of *Eucalyptus sp.* was affected by the structure of soil layer, slope of parcel, and forest management (weeding, etc.) more than soil components.

Table 3.17. Results of soil analysis of samples collected from the trenches of the selected parcels in 2010

Code of parcel	pH	Organic matter (%)	P (ppm)	Ca^{+2} (cmol$_c$/ kg)	Mg^{+2} (cmol$_c$/ kg)	K^{+} (cmol$_c$/ kg)	$Al^{+3}H^{+}$ (cmol$_c$/ kg)	Soil classification
A3F5-1	6.23 (±0.15)	0.15 (±0.04)	1.78 (±0.38)	3.27 (±0.90)	0.67 (±0.22)	0.03 (±0.01)	0.00	Sandy loam-Sandy clay loam
A3F6-1	5.93 (±0.31)	0.15 (±0.04)	1.12 (±0.39)	1.60 (±0.53)	0.55 (±0.39)	0.04 (±0.02)	0.20 (±0.35)	Sandy soil-Sandy clay loam
AMA7-1	5.90 (±0.10)	0.27 (±0.14)	1.78 (±0.38)	2.27 (±1.03)	0.53 (±0.05)	0.08 (±0.05)	0.00	Sandy silt- Sandy clay loam
AMA10-3	5.68 (±0.13)	0.18 (±0.10)	2.00 (±0.54)	0.48 (±0.15)	0.06 (±0.04)	0.03 (±0.02)	0.00	Sandy silt- Sandy clay loam
RMb11-1	5.57 (±0.06)	0.33 (±0.14)	1.56 (±0.77)	1.40 (±0.60)	0.58 (±0.14)	0.03 (±0.01)	0.13 (±0.23)	Sandy silt- Sandy loam
RM17-1	5.43 (±0.33)	0.87 (±0.77)	1.67 (±0.86)	2.05 (±0.30)	1.04 (±0.25)	0.05 (±0.05)	0.35 (±0.41)	Sandy loam-Sandy clay loam
Demonstration farm	5.73 (±0.31)	0.45 (±0.43)	6.68 (±2.91)	1.93 (±1.27)	0.81 (±0.75)	0.08 (±0.03)	0.00	Sandy silt- Sandy loam

Source) Matsubara et al. 2011
Note 1) Criteria for analysis in Paraguay;
pH: > 5.2 : strong acidic, 5.3-5.6: acidic, 5.7-6.4: weak acidic, 6.5-7.5: neutral
Organic matter: > to 0.8: very low, 0.9-1.2: low, 1.3-1.7: usual, 1.8-2.2: high, 2.3 +: very high
P: > 12: low, 13-30: usual, 31-50: high, 50 +: very high
Ca: > 3.0: low, 3.1-6.0: usual, 6.1 +: appropriate
Mg: > 0.6: low, 0.61-1.1: usual, 1.2 +: appropriate
K: > 0.12: low, 0.13-0.30: usual, 0.31 +: high
Al: > 0.2 small, 0.3-0.7: acceptable, 0.8-1.0: toxicity, 1.1 +: strong toxicity
Note 2) Standard deviation in parentheses

In order to find the way to improve tree growth in forested parcels, the project promoter conducted a field test. For the test, 2 parcels with *E. grandis* were selected. These parcels, code named as A3F5-1 and ATG1-1, had poor carbon stocks increase. In these parcels, 3 small experimental plots with (1) application of green manure and cattle dung; (2) application of green manure; and (3) control without treatment were established. After applied treatment, tree height and DBH of all trees in the plots were measured every 3 months.

The results of tree height measurement in 2 parcels are shown in Figure 3.21-22.

Significant difference in green manure and cattle dung was not observed in the results of tests from two parcels. This could suggest that if green manure and cattle dung was applied late in forestation, the effect to the growth of *E. grandis* would be negligible. As suggested by the results of farmer survey, management of forest for the first year, including land preparation, taking care of the supplied seedlings, timely planting, and weeding, was critical to have good growth of *Eucalyptus sp.*

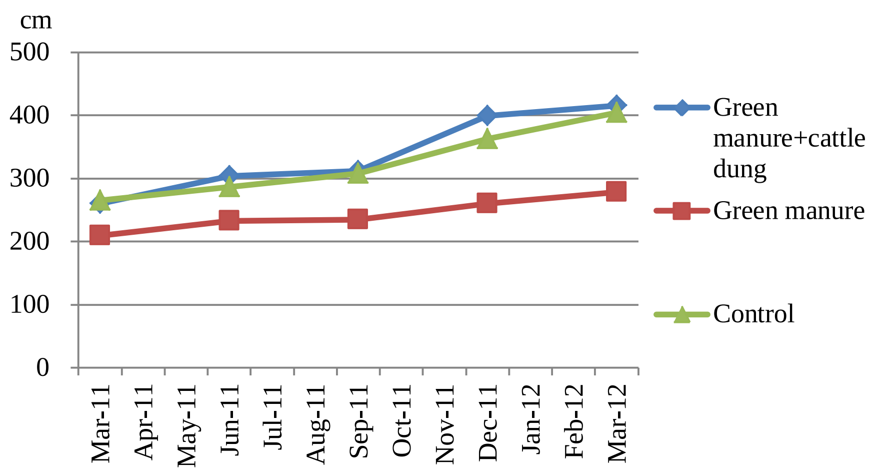

Figure 3.21. Trends in the average tree height of *E. grandis* in A3F5-1 from different treatment (Matsubara et al. 2012)

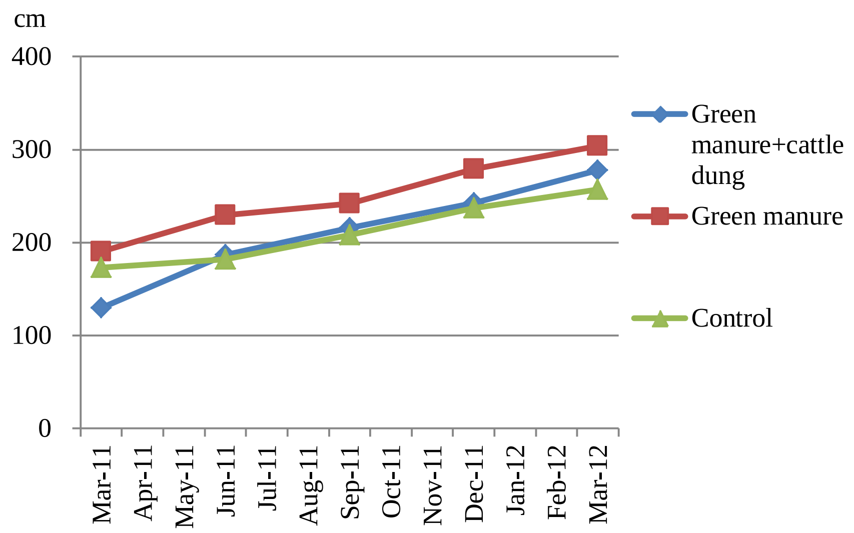

Figure 3.22. Trends in the average tree height of *E.grandis* in ATG1-1 from different treatment (Matsubara et al. 2012)

To improve the growth of planted trees, experiments to ensure the growth of *Eucalyptus sp.* from the planting was undertaken in the Quiindy demonstration farm in 2010. This experiment included four plots: (1) conventional method of planting (hole depth of 15 cm); (2) green manure + 15 cm depth; (3) green manure + 30 cm depth; and (4) green manure + cattle dung + 30 cm depth. After establishing experimental plots and planting seedlings, tree height and DBH of all trees in the plots were measured every 3 months. The results of the average height of trees are shown in Figure 3.23.

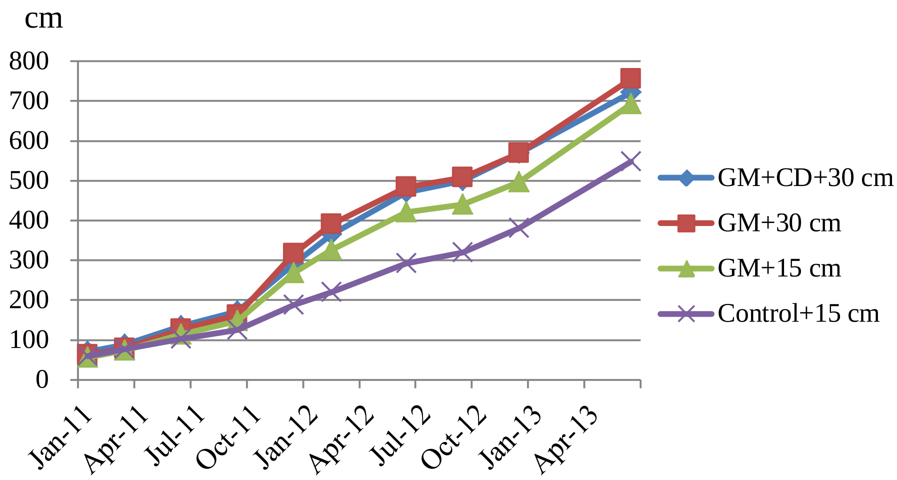

Figure 3.23. Trends in the height growth of *E. grandis* in Quiindy demonstration farm (GM; green manure, CD; cattle dung)

Carbon stocks were estimated in June 2012, as shown in Table 3.18.

Table 3.18. Estimated carbon stocks in *E. grandis* in Quiindy demonstration farm in 2012

Treatment	Number of trees	Average DBH (cm)	Average tree height (cm)	Average carbon stock intree (kgC/ tree)
GM+CD+30 cm	29	4.07 (±1.34)	470.93 (±124.85)	2.05 (±1.75)
GM+30 cm	29	3.52 (±1.18)	482.69 (±129.05)	1.55 (±1.14)
GM+15 cm	29	3.34 (±1.72)	420.24 (±168.99)	1.63 (±1.89)
Control+15 cm	26	2.54 (±1.39)	291.92 (±126.02)	0.72 (±1.05)

Note) Standard deviation in parentheses

The results of T-test for carbon stocks in each treatment group to control were all significant ($p < 0.05$). Therefore, green manure planted at the initial stage of forest establishment was effective for the growth of *E. grandis*. On the other hand, one-way analysis of variance with respect to depth of planting indicated that the effect of a deeper planting hole to tree growth was not significant.

Seed quality of *Eucalyptus sp.* was checked to find if there were any deficiencies. In this A/R CDM project, the majority of *Eucalyptus sp.* seeds were provided by INFONA. The origin of *Eucalyptus sp.* seeds from INFONA was confirmed as follows.

(1) Seeds of *E. grandis* were collected from the Pirapo field located in the Forestry Development Center of INFONA in the Department of Itapúa. The parent tree was directly imported from Australia.

(2) Seeds of *E. camaldulensis* were collected from the forest of INFONA in Villa Florida, the Department of Misiones. The parent tree was grown from seeds directly imported from Australia;

The seeds used for seedling production were considered genetically sound.

From the results of the pre-monitoring in 2010, the monitoring plan was reviewed and formal monitoring was suspended since the GHG removals did not exceed the baseline carbon stocks.

The main findings obtained by the pre-monitoring activity are shown below:

(1) The stratum set as tree species, planting year, and planting space should be subdivided depending on the growth in each stratum, or the parcels of which carbon stocks were below the baseline should be excluded from monitoring in order to cope with the large difference in tree growth. If the monitoring were limited to excellent parcels, the potential area for CER would be around 40 ha.

(2) The large difference between the monitoring and verification results suggested a review of survey method was necessary. In order to ensure coincidence of monitoring and QC/QA work, establishing a sample plot with the same number of trees, instead of the same area size, was desirable. All the trees to be measured should be tagged to differentiate each other.

(3) Main causes of poor tree growth were drought and inappropriate forest management (no weeding, etc.). If the forested area was well-managed, high growth of trees was expected, as verified in the demonstration farm. Intercropping green manure between tree rows was effective for tree growth at the initial stage of forestation, though its later introduction was ineffective.

(4) It took several months to monitor the positions and areas of parcels as well as to monitor land tenure, due to the requirement of 100 % measurement. For alleviating this task, restriction of monitoring to excellent parcels would be effective.

(5) The large amount of baseline carbon stocks prevented ensuring sufficient amount of net anthropogenic GHG removals by sinks. The project promoter accepted almost all the requests for forestation from farmers, including those farmers who had a number of native oil palms to collect fruit for sale. These palms were assumed not to be cut by farmers. Counting the palms in baseline resulted in the large increase of baseline carbon stocks. Baseline estimation should not to be over-conservative.

For baseline carbon stocks estimation, “the guidance on conditions under which the change in carbon stocks in existing live woody vegetation are insignificant” version.01 approved by the 46th of the CDM EB in 2009 (EB46) stated that “existing trees and/or shrubs within the area are allowed to remain are not expected to be impacted by A/R project activities, and shall be excluded from estimates of project net GHG removals by sinks.” After this guidance was published, the palms in this A/R CDM project would not be necessary to be counted in baseline carbon stocks.

In addition, the 23rd meeting of the A/R-WG held in 2009 clarified that “the changes in carbon stocks in herbaceous vegetation to the baseline net GHG removals by sinks is insignificant and shall be accounted for as zero.” This meant the carbon stocks in below ground biomass of grassland would be regarded to be zero.

If these changes were applied, it would have been possible that the baseline carbon stocks in the project were decreased to 1.8 and 1.9 tC/ ha of cropland and grassland respectively from current 11.88 and 10.32 tC/ ha.

3.6 Monitoring activities

When the pre-monitoring was conducted in 2010, only 20 parcels with 39.2 ha had carbon stocks of over 10 tC/ ha. The excellent parcels increased to 62 parcels with 92.03 ha by July 2012, implying 74 % of 124.50 ha of *Eucalyptus sp.* The survey for selecting the parcels having carbon stocks of more than 10 tC/ ha was conducted by setting tentative plots having 16 trees (4 by 4, or 7.5 m by 9 m according to the planned planting density) in the parcels which were observed to have a good growth part. Number of trees except non-survived plants, tree height, and DBH were measured in the selected plots. This survey provided useful information relating to excellent parcels before starting formal monitoring.

The difficulty of monitoring was that there was large difference of tree growth in the same parcel, depending on soil condition, method of management (grazing in parcels, weeding, etc.), and existence of supplemental plantings. Some SSFs did not plant as planned and planted less than the forest size definition (0.5 ha), even if a part of the parcel was excellent. Therefore, the monitoring of location and area of parcels by GPS was conducted not only over the whole parcel but also on the excellent part in the same parcel. If the planted area did not exceed the threshold of forest definition (0.5 ha), or the area including forested area plus a small forest adjacent to the parcel did not satisfy the definition of forest size, those parcels were excluded from monitoring.

The parcels that did not satisfy the definition of forest in Paraguay were examined in 2012. The results indicated that there were parcels which were planted in less than 0.5 ha, or planted but damaged by drought, then abandoned forestation later. Those parcels were excluded from monitoring. The list of excluded parcels is shown in Table 3.19.

Table 3.19. Parcels excluded from the monitoring in 2012

Code of parcel	Planned area of *Eucalyptus sp.* (ha)	Planted area (ha)	Area for CER (ha)	Observations
A20J9-1	0.27	0.22	0.21	*E. grandis* was planted. *Grevillea robusta* was planted adjacent to *E. grandis* but most of *Grevillea robusta* was damaged by drought. Not satisfy forest definition.
AI11-1	0.55	0.45	0.32	*E. grandis* was planted. The planted area did not satisfy forest definition.
ALP4-1	0.50	0.46	0.46	*E. grandis* was planted. The planted area did not satisfy forest definition.
ASJ3-1	0.72	0.38	0.38	Half of *E. grandis* was lost by drought. The remaining area did not satisfy forest definition.
ASJ5-1	0.52	0.29	0.19	Planted area did not satisfy forest definition.
AY6-1	0.57	0.34	0.19	ditto
RMb17-1	0.37	0.31	0.21	ditto
Total	3.50	2.44	1.96	

Since 2010, it was considered that parcels with more than 10 tC/ ha of carbon stocks were found only in *Eucalyptus sp.* forest. However, there existed several parcels of *Grevillea robusta* with high growth, almost the same as the plot of *Grevillea robusta* established as AF in the demonstration farm that recorded 8.0 tC/ ha of carbon stocks in December 2011. After a monitoring survey, the following 6 parcels were found excellent and added for CER in 2012 (Table 3.20).

Table 3.20. Parcels with *Grevillea robusta* added to the monitoring activity in 2012

Code of parcel	Planned area of *Grevillea robusta* (ha)	Planted area (ha)	Area for CER (ha)
ALP1-1	0.66	0.59	0.16
RSB1-1	0.56	0.51	0.51
AOC4-2	6.34	5.19	2.13
ALP3-1	1.16	1.13	1.13
A3F4-3	0.63	0.65	0.21
A3F9-2	1.07	0.85	0.85
Total	10.42	8.92	4.99

Based on the monitoring results, the planted area and area for CER with excellent growth of *Eucalyptus sp.* and *Grevillea robusta*, satisfying the forest definition of Paraguay, were compiled in 2012 as shown in Table 3.21. The area of land use before planting was also included.

Table 3.21. Area total of monitored parcels in 2012

Stratum	Tree species/ planting year[a]	Results of monitoring				Baseline land use[e]	
		Planned area (ha)[b]	Area for CER (ha)[c]	Planted area (ha)[d]	Number of parcels	Cropland (ha)	Grassland (ha)
S1	EG/ 2007	15.65	13.59	17.61	23	11.61	1.99
S2	EG/ 2008	13.50	9.59	13.38	15	3.80	5.79
S3	EC/ 2007	14.36	7.71	11.50	9	2.75	4.96
S4	EC/ 2008)	57.16	45.63	47.56	17	1.91	43.72
S5	GR/ 2007	1.22	0.67	1.10	2	0.67	0.00
S6	GR/ 2008	0.63	0.21	0.65	1	2.13	0.00
S7	GRA/ 2007	1.16	1.13	1.13	1	1.13	0.00
S8	GRA/ 2008	7.41	2.98	6.04	2	0.08	0.97
Total		111.09	81.51	98.96	70	24.08	57.43
S1+S2	EG	29.15	23.18	30.99	38	15.40	7.78
S3+S4	EC	71.53	53.34	59.06	26	4.66	48.68
S5+S6+ S7+S8	GR & GRA	10.41	4.99	8.91	6	4.01	0.97
Total		111.09	81.51	98.96	70	24.08	57.43

[a] EG: *E. grandis*, EC: *E. camaldulensis*, GR: *Grevillea robusta*, GRA: GR with AF
[b] Area of parcel in registered PDD
[c] Area which was assumed to have more than 10 tC/ ha
[d] Actually planted area
[e] Area of land use before planting (cropland or grassland)

In comparison with the planned area in the registered PDD, the monitored planted area was around half (99 ha/ 215 ha), and the number of parcels decreased to 30 % of the planned parcels (70/ 240). The percentage of reduction was larger in the number of parcels than in the planted area. This indicated that plenty of parcels belonging to less SSFs were low in tree growth, and were excluded from the monitoring. For tree species, *E. camaldulensis* was highest in the share of monitored area. The area applicable for CER of *Grevillea robusta*, which was slow-growing when compared to *Eucalyptus sp.*, was only 5 ha. The cases where farmers cut down existing trees in the cropland or grassland were rarely seen. Native oil palm in particular was not cut and some farmers newly planted oil palm seedlings in their cropland for AF.

Survey of carbon stocks on entire parcels was conducted from July to August 2012. The stratum was changed to only tree species (*E. grandis*, *E. camaldulensis*, and *Grevillea robusta*) in the monitoring. The allometric equation for each species was determined and was adjusted to satisfy the rule established in the methodological tool. The developed allometric equation was as follows:

<u>*E. grandis*</u>

$SV_{i,j,k} = 3 * 10^{-4} * (DBH_{i,j,k})^{2.243}$

($n=15$, $R^2=0.9119$, $p=0.056$)

<u>*E. camaldulensis*</u>

$SV_{i,j,k} = 2 * 10^{-4} * (DBH_{i,j,k})^{2.3683}$

($n=10$, $R^2=0.9767$, $p=0.038$)

<u>*G. robusta*</u>

$SV_{i,j,k} = \pi * ((DBH_{i,j,k})/100/2)^2 * H_{i,j,k} * FF_i$
(n=10, R^2=0.9917, p=0.042)

Where,
$DBH_{i,j,k}$: DBH of the stratum *i*, permanent sample plot *j*, and tree *k* (cm)
$H_{i,j,k}$: Height of stratum *i*, permanent sample plot *j*, and tree *k* (m)
FF_i : Form factor of stratum *i*
Application range: 9.5 cm< DBH < 30.0 cm

The carbon stocks in the entire parcels monitored in the project area are shown in Table 3.22.

Table 3.22. Estimated carbon stocks in the monitoring in 2012

Tree species	Area for carbon credit (ha)	Stem volume (m^3/ha)	Carbon stocks (tCO_2) [a]
E. grandis	23.18	1,563.44	3,234.65
E. camaldulensis	53.34	3,508.17	9,060.92
Grevillea robusta	4.99	129.03	273.15
Total	81.51	5,200.64	12,568.72

[a] It should be noted that, by the rule of A/R CDM, GHG emissions occurred during the implementation of A/R CDM project was regarded as zero.

The marginal error of carbon stocks calculated in accordance with the methodological tool of A/R CDM was 11.45 %. If the error exceeded the required precision level of 10 %, a certain rate of carbon stocks (6 % in this case) should be deducted from the total (UNFCCC 2012d). The adjusted carbon stocks P (t) were as follows:

$P (t) = 12,568 * (1-0.06) = 11,813\ tCO_2$

Leakage (Lt) was calculated as follows, since leakage (Lt) was set as 15 % of P (t).

$Lt = 11,813 * 0.15 = 1,772\ tCO_2$

Baseline carbon stocks ⊿CBSL was calculated by multiplying unit carbon stocks of 11.88 tC/ ha of cropland and 10.32 tC/ ha of grassland with the area of cropland (24.08 ha) and grass land (57.43 ha).

$\triangle CBSL = (11.88 * 24.08 +10.32 * 57.43) * 44/12 = 3,222\ tCO_2$

The net anthropogenic GHG removals by sinks (CER) were calculated as follows:

$CER = P (t) - \triangle CBSL - Lt = 11,813 - 3,222 - 1,772 = 6,819\ tCO_2$

Consequently, the realized monitored area and CER amount was 81.51 ha and 6,819 tCO_2 respectively, contrasting with 215.2 ha and 23,538 tCO_2 planned in the PDD. This indicated that CER area decreased by 62 % and CER amount by 71 % respectively from the planned size and amount.

Contribution of individual farmers to the creation of CER was calculated as shown in Table 3.23. The number of farmers having excellent parcels (70 parcels in total) was 56, some of whom had more than 2 parcels to be monitored. Among them, some farmers who had negative CER were included, because their parcels had the high possibility to accumulate carbon over baseline carbon stocks in the second monitoring activity.

Table 3.23. Contribution to CER by farmers who were grouped into forestation scale in 2012

Stratum by forested area	Number of farmers (households)	Area for carbon credit (ha)	CER (tCO_2)	Percentage of CER (%)
More than 2 ha	7	50.00	4,894	71.77
1ha - less than 2 ha	7	9.91	437	6.41
0.5 ha – less than 1 ha	26	17.03	1,201	17.61
Less than 0.5 ha	16	4.57	287	4.21
Total	56	81.51	6,819	100.00

When the farmers having more than 2 ha of excellent parcels were summed up, the share of CER was found to be 72 %, whereas the number of them was just 7. Four out of 7 were middle-scale farmers whose share was 57 % of CER. This meant the remaining 49 farmers contributed to only 28 % of the entire CER. The reason of the low contribution of SSFs to the creation of CER was considered to be smallness of their forested area, highly degraded land to grow trees, and poor management. On the other hand, the middle-scale farmers had larger forested areas than SSFs, and had knowledge and capacity to manage the land well. This fact suggested that to ensure sufficient amount of CER in low income rural area, appropriate number of farmers with middle-scale holdings and over should be co-opted to participate in A/R CDM projects.

Before determining the participants who certainly would be able to continue forestation activity, the project promoter confirmed requested farmers' intention for forestation by interviewing and on-site observation of land management. The number of participants, however, gradually decreased, from 325 farmers with 301 ha, for whom the location of parcel to be forested was surveyed by GPS, to 239 farmers with 256 ha for the distribution of seedlings, to 167 farmers with 215 ha for the registered A/R CDM project, to 131 farmers with 182 ha at the pre-monitoring activity, and finally to 56 farmers with 82 ha for the first issuance of CER, as shown in Table 3.24.

Table 3.24. Trend of planted area and participants from 2007 to 2012

Classification	*Eucalyptus sp.* (ha)	*Grevillea robusta* (ha)	Area total (ha)	Participant farmers (households)
Baseline survey (2006-2007)	—	—	301.20	325
Provision of seedlings (2007-2008)	172.80	82.90	255.70	239
Registration with the CDM EB (2008)	142.06	73.10	215.16	167
Pre-monitoring (2010)	121.07	60.32	181.49	131
First issuance of CER (2012)	76.62	4.99	81.51	56

Of the farmers to whom the project promoter distributed seedlings at their request, 69 farmers with 15.1 ha were excluded from the A/R CDM project, because their planted area was less than the minimum area of the forest definition (0.5 ha) in Paraguay (Matsubara et al. 2011). The reasons for the decreasing number of farmers and parcels other than not satisfying the least forest area were: (1) changeable intention of SSFs; (2) impact of droughts; (3) low growth of planted trees; and (4) prohibition against adding new parcels to the project even if the parcel was located within the registered farmer's own land and had the same baseline carbon stocks as the registered parcel, once the project was registered, according to the methodology (UNFCCC 2012c).

After monitoring activity conducted by the project promoter, the verification team of UNA and INFONA randomly selected 16 parcels (23 %) in total from 70 monitored parcels. The verification team visited the farmers and parcels to measure GPS coordinates and trees in the permanent plots, confirm land tenure, and interview farmers about land use relating to leakage (Figure 3.24). The comparison of the results of monitoring and of verification is shown in Table 3.25.

Figure 3.24. QC/QA activity of UNA (left) and INFONA (right) in parcels monitored by the project promoter (Photo by Eiji Matsubara in 2012)

Table 3.25. Comparison of the results of monitoring and verification in 2012

Code of parcel	Monitoring results			Verification results of UNA and INFONA			Difference		
	Area (ha)	Carbon stocks per unit area (tC/ ha)	Carbon stocks in parcel (tC)	Area (ha)	Carbon stocks per unit area (tC/ ha)	Carbon stocks in parcel (tC)	Area (%)	Carbon stocks per unit area (%)	Carbon stocks in parcel (%)
A20J5-1	2.05	99.28	203.45	1.96	98.13	192.20	4.43	1.16	5.53
A20J7-1	0.77	73.68	56.46	0.71	69.04	48.89	7.59	6.30	13.41
A3F11-1	0.48	29.91	14.29	0.59	31.81	18.63	-22.61	-6.35	-30.39
A3F9-1	0.77	37.40	28.78	0.79	37.04	29.31	-2.85	0.97	-1.84
AI5-1	0.82	37.64	30.79	0.78	38.28	29.85	4.69	-1.71	3.07
ALP3-1	1.13	11.47	12.91	1.11	11.64	12.96	1.10	-1.54	-0.42
AMA14-1	2.62	85.35	223.64	2.55	79.11	201.81	2.64	7.31	9.76
ASJ10-1	0.63	37.05	23.50	0.76	41.19	31.40	-20.18	-11.17	-33.61
RM9-1	0.49	52.20	25.54	0.47	48.66	22.91	3.80	6.78	10.33
RA10-1	2.29	36.39	83.38	2.25	37.80	84.89	1.99	-3.89	-1.82
RC13-1	0.96	34.26	32.79	1.15	36.14	41.71	-20.59	-5.49	-27.21
RM17-3	2.56	67.70	173.23	2.49	72.05	179.44	2.67	-6.43	-3.59
RM17-4	0.56	63.15	35.61	0.54	68.15	36.67	4.56	-7.91	-2.99
RRC3-3	0.82	18.86	15.45	0.78	20.57	16.13	4.26	-9.05	-4.41
RRS18-1	0.72	19.67	14.17	0.76	20.85	15.82	-5.32	-6.02	-11.66
RSB1-1	0.55	15.49	8.58	0.57	15.98	9.13	-3.29	-3.12	-6.51
Total/ Average	18.21		982.57	18.26		971.76	-0.27		1.10

The results indicated that 3 parcels in area and one parcel in carbon stocks per unit area caused a difference of more than 10 %; however, the value of monitoring was less than that of verification. The difference in area and carbon stocks of 16 parcels in total was around 1.0 % including the results from interviewing farmers. The verification team concluded that monitoring activities were appropriate. The Directors of UNA and INFONA issued the verification certificate to the project separately after completing the verification reports.

According to CDM standard (UNFCCC 2012a) and guideline of A/R CDM (UNFCCC 2012c), changes in the project boundary (limited to reduction in project area) and changes in the number of sampling plots, etc. were acceptable, but a revision of the registered PDD based on the changes was required. The revision of the PDD led to increase of transaction cost, because it required extensive changes to the PDD such as confirmation of methodology application, stratum setting, confirmation of additionality and leakage, calculation of carbon stocks, and monitoring plan, in contrasting with the registered PDD.

After completing the monitoring report and revision of the PDD, verification by DOE was conducted on site in February 2013. The main points discussed with DOE and the subsequent responses of the project promoter were as follows:

(1) Treatment of additional parcels that were not described in the registered PDD;
(2) Margin of error;
(3) Treatment of forested parcels below the definition of forest;
(4) Monitoring of leakage.

As for treatment of additional parcels that were not described in the registered PDD, the parcel of RM17-8 (1.78 ha) owned and forested by the same participant farmer and located in part of the same land as other monitored parcels, was overlooked in the PDD prepared in 2008. After registering the project, the error was found and the RM17-8 was added to the monitoring activity. The DOE stated that the parcel should be excluded from CER calculation, because the methodology interpreted that changes in the stratum were accepted, but not the correction of error, even if the baseline condition was proved to be the same as other monitored parcels within the same owner‘s land. This parcel must be excluded from the monitoring results.

The margin of error for the project was large due to large standard deviation (*Eucalyptus sp*. 44.70 ± 20.87 tC/ ha, *Grevillea sp*. 17.24 ± 6.67 tC/ ha), because all the parcels including excellent to low-middle level carbon stocks were surveyed at the same time. The calculated margin of error was 11.45 %, exceeding the precision level threshold of 10 %. The size of the error resulted in 6 % reduction in carbon stocks in accordance with A/R CDM tool (UNFCCC 2012d). In the project, the individual parcels were surveyed independently by setting a permanent sample plot at the part where the tree growth represented average growth in the parcel. The parcel targeting CER was made uniform by excluding a part of land with inferior tree growth. Therefore the sampling method should not be applied to the parcels of the project, and the calculation of margin of error of carbon stocks in integrated manner was irrational.

The monitoring cost was high in this project, because 75 % (42/ 56) of monitored farmers were SSFs with a forested parcel of less than 1 ha (shown in Table 3.23), with a small contribution to carbon stocks, whereas the monitoring activities covered all the parcels, of which tree growth was usually irregular. The compensation of margin of error was deducted from CER to cover the high irregularity of tree growth among farmers' parcels. An A/R CDM project focusing on smallholders had great disadvantage under the present system.

According to the decision of UNFCCC, carbon stocks of forest were measured in the forest defined by the Party (UNFCCC 2001a). The defined forest did not differentiate planted forest from forest in general. The project promoter assumed that the definition was applied to the area of forest with forested area plus the area of natural forest if the forested area was adjacent to the natural forest, or the entire forested area in the parcel if a part of the forested area selected for monitoring was less than 0.5 ha (the least area of forest defined in Paraguay). The number of monitored parcels targeting CER with less than 0.5 ha was 18. After the opinion of the project promoter was accepted, carbon stocks in 18 parcels were counted in CER. The poorer parts of the 18 parcels were regarded as the lands where the owners had planted seedlings voluntarily, and excluded from project boundary.

Leakage was the increase in GHG emissions by sources or decrease in carbon stocks in carbon pools that occurred outside the boundary of an A/R CDM project and was measurable and attributable to the A/R CDM project (UNFCCC 2012e). In this project, leakage was considered insignificant when crop production or grazing was displaced within the owner's land. The interview to farmers was conducted using a prepared form. The results indicated that almost all farmers did not displace activity due to no previous use of the forested land, or displaced it within their own land. Practically the leakage in the project could be regarded as zero, if the leakage was applied to the impact to the outside of farmers' owned land, however 15 % of actual net GHG removals by sinks was deducted as leakage.

The on-site measurement results by DOE were in sufficient agreement with the monitoring results (less than determined error range). The farmers interviewed replied to the DOE that they were satisfied with the forested area though no economic benefit had accrued before harvesting and selling. The certificate of land occupation was put in a frame and kept carefully by farmers, and shown on site when requested by the DOE.

After on-site verification by the DOE and addressing the corrective action requests as well as clarification requests pointed out by the DOE, the monitoring report and PDD was revised. The issuance of CER was requested to UNFCCC in June 2013.

The CER was issued in August 2013, when 7.5 years had passed from the beginning of an A/R CDM activity in the project area.

3.7 Discussion on the solution of issues to realize an A/R CDM project

In Paraguay, the technical difficulty such as land eligibility and estimation of carbon stocks (baseline, project scenario, and leakage) was solvable by the objective assessment of the local situation through various on-site studies, though these required high cost and long time. However, the decisive was social and institutional issues such as organizing and facilitating farmer participation in the project, creating agreement between the project promoter and individual farmers, clarifying the rights relating to land, and passing through the procedures of DNA.

The community participation approach adopted in Paraguay placed importance on raising awareness of farmers. It was necessary to establish a farmers group in each community of the targeted area, unless the existing organization of farmers in communities was functional and activated. At this time, the selection of a leader farmer and the approach adopted by the project promoter was important. A challenge was "meeting all stakeholder expectations and constraints through recognizing that people have different motivations and interests" (Rennaud et al. 2012). "Peculiarities of the carbon market such as carbon property rights often created uncertainty that must be handled delicately" (ibid.). Cacho et al. stated that "one strategy for enhancing the cost-effectiveness of engaging smallholders in a CDM project might be to develop projects whereby smallholders participate in groups" (Cacho et al. 2003). The formulation of an A/R CDM project would be facilitated if the project was aimed at communities that had been already organized.

In Paraguay, the project promoter recommended for farmers to prepare a farm plan which envisaged appropriate land use change, management methods, and activities to improve their livelihood. The needs of forestation on their degraded land were known because farmers placed forestation in their farm plans. The plan made by individual farmer to forest their land themselves was considered necessary to build ownership of forestation and to avoid losing the long-term commitment of participants. In fact, the communal land requested by community for forestation was not planted, due to lack of willingness within the community to forest the land where no private benefit could be expected. From the questionnaire survey on forestation conducted in the project area, the potential for a forestation project at a scale of 300 ha was found. For providing an incentive to farmers, BPP was established. The project promoter required the participant farmers to pay for 30 % of the material cost, when the project promoter provided the external materials necessary for the improvement of farming or income generating activities. BPP was applied to forestation as well as to MIG activities.

The A/R CDM required that the rights enabling determination of the owner of the forestry CER to be issued for the project should be clarified (UNFCCC 2012a). In Paraguay, the project promoter entered into an agreement with individual farmers to determine the distribution of costs and benefits related to forestation. The carbon credit market was unstable in general, especially the market for A/R CDM projects. The A/R CDM project had a risk not being registered with the CDM EB due to the unique difficulties in the methodology, and a risk of non-permanence (low price and avoidance of buyer entities). The project promoter determined to take all the risks relating to carbon credit by having all the benefit of forestry CER, while the farmers could take all the direct benefit from tree sale and products from the forested land. There was an example of other A/R CDM project, in which the project entity would use “100 percent of the carbon revenues to cover its upfront investments, and the farmers are entitled to 100 percent of the revenues from timber and other forest products” (WB 2011b). By obtaining all the direct benefits of trees, famers were expected to enhance the incentive for forestation and forest management.

On the other hand, the project needed to “carefully communicate to smallholders to ensure they clearly understand the value of the carbon payment relative to other benefits” (Shames et al. 2013). The project promoter expressed in the agreement with the farmers that the net benefit from CER was intended to use for communities, not for individual participants, if such benefit was obtained from the A/R CDM project. For bearing the forestation cost, the agreement was that the participant farmers provided labor for land preparation, planting seedlings, weeding, pruning, thinning, and harvesting from the view point of BPP, whereas the project provided training and seedlings for free. Large number of farmers participated in the A/R CDM project involving smallholders caused the significant increase in time and transaction cost even for collecting the signed agreements. As the way to contact the farmers was to visit them, the project member needed to visit repeatedly if they were not at home. Initially, the project promoter signed the agreement with a leader farmer in each community, and asked the leader to collect signatures of participant farmers belonging to the community in the list attached to the agreement. However, the project promoter and each individual farmer must have signed on each agreement at the end, since signing the list of participant members, not an individual agreement, was considered invalid by the DOE.

The issue always raised in A/R CDM project involving smallholders was land right. In Paraguay, few SSFs had legal land titles. In interviews with farmers, many SSFs migrated to the untouched land several decades ago, developed the land, and built livelihood, regardless of the land rights, because of characteristics of the country which was rich in land compared to population. The clarification of land rights became a challenge when smallholders were involved in an A/R CDM project. The national civil law of Paraguay stated that the entitlement to the land was handed to settlers if the settlement has been existent for more than 20 years without interruption, subject to legal administrative procedures that settlers were asked to take (UNFCCC 2009a). Obtaining the confirmation of land use rights from the country for all the participants led to cost increase and delay to formulate an A/R CDM project.

According to the methodology, project participants should have established the control over forestation "for at least two-thirds of the total area of land planned for A/R CDM project" before registration of the project (UNFCCC 2012a). In Paraguay, the project acquired certificates of land occupation, used as demonstration of land right, for 239 farmers for whom seedlings were provided. The necessary personal information to propose issuance of the certificate to INDERT included name of land right holders, nationality number, area of occupied land, location, etc. The project promoter needed to visit the farmers repeatedly in order to collect information and correct wrong information provided by the farmers, which sometimes involved a conflict of inheritance rights. This work resulted in high increase of time spent and expenses.

Moreover, the problem of insufficient capacity of DNA appeared to delay progress of the project. The first delay of DNA procedures was determination of the forest definition of Paraguay. The process from determining the definition to posting it on the web page of the UNFCCC was not achieved until 2008 after the project promoter requested it in 2006. The second delay was to issue a declaration that the project was implemented in low income communities, of which issuance was a condition set for the project applied to the small-scale A/R CDM methodology. It took 1.5 years from the request to acquisition of the declaration. The last delay was issuing LoA for the project, which took more than 1 year from the initial request to issuance of the document with proper contents corresponding to the CDM rule. These delays increased the uncertainty of the project, and led to an increase in transaction costs.

For CER obtained by the A/R CDM project in Paraguay, the performance of SSFs was insufficient. The number of participant farmers and area of forestation for CER decreased from 325 farmers with 301.2 ha in 2006-2007 to 56 farmers with 81.51 ha. The time and expense spent for the cancelled parcels were wasted. As for number of farmers, only 17 % (56/ 325) of farmers whose parcels were measured by GPS were effective during the project. As for the farmers for whom seedlings were provided, 23 % (56/ 239) were effective. This demonstrated that the waste rate, meaning the proportion of activity implemented but not generated CER to all activities, reached around 80 %. The project promoter signed agreements with 239 farmers, but those of more than 70 % were useless if compared with only 56 agreements which were used for CER. When compared the amount of issued CER with the number of farmers who contributed to the issuance of CER, the share of 7 farmers having more than 2 ha of forested parcel was around 72 % in the total CER. Four out of 7 were middle-scale farmers. The remaining 49 farmers, consisting of SSFs, contributed to only 28 % of CER in total. The problems of not a few SSFs were changeable intention, tendency not to keep an agreed plan, and neglect of appropriate forest management. The fact of poor performance of SSFs indicated that the participation of middle-scale farmers in an A/R CDM project, rather than excluding them, was quite effective to ensure good performance of forestation or high amount of carbon credit. The A/R CDM project in India, in which only low income farmers participated, has succeeded in obtaining CER almost the same amount of CER as planned (UNFCCC, 2009b). The formulation of the A/R CDM project like India would not possible in Paraguay, where the land of SSFs was relatively larger than in Asia (around 5.5 ha in national average for SSFs), farmers were living dispersedly, and the existing organizations such as local government and NGO were not strong enough to collaborate with the project promoter. There was a limit of effectiveness of technical assistance to SSFs by the project promoter in Paraguay. The poor performance of SSFs led to high cost of monitoring due to the low and irregular growth of trees in their parcels. On the other hand, middle-scale farmers were found to have a sound attitude towards forestation and to manage their forested area appropriately.

Uniqueness of an A/R CDM project involving SSFs was that: (1) large number of participant SSFs were required to ensure a certain scale of the project; (2) small plantation parcels were scattered widely in targeted communities; and (3) forest management capacity of SSFs was low. It was obvious that the forestation project targeting large number of SSFs was more costly than the project targeting small number of middle/large-scale farmers. The low management capacity led to inefficiency or high rate of loss of the project activity. Acquisition of CER from an A/R CDM project involving SSFs by solving difficulties was possible if capability of the project promoter as well as sufficient time frame and funding were ensured; however, the inefficiency to target SSFs would not be essentially solved.

4 Evaluation of the A/R CDM project in Paraguay

4.1 Introduction

Five issues relating to an A/R CDM project, that is: (1) solution of issues to realize an A/R CDM project; (2) economic feasibility; (3) reduction of the transaction cost (4) contribution to sustainable development; and (5) effectiveness of AF were raised in order to confirm a hypothesis that a carbon benefit obtained from the A/R CDM project involving smallholders improves the lives of smallholders. Those 5 issues were set to examine 3 premises that: (1) CER could be issued to an A/R CDM project involving smallholders; (2) carbon benefit could be obtained by selling CER to buyers at the price greater than transaction cost; and (3) participant smallholders could obtain benefit from the A/R CDM project.

Among 5 issues, the solution of issues to realize an A/R CDM project was examined in chapter 3. It found that CER could be issued to an A/R CDM project involving SSFs, if difficulties including funding were solved. In this chapter, the remaining 4 issues were examined by using the results of the A/R CDM project in Paraguay, together with the results of additional surveys conducted in the process of implementing the A/R CDM project.

4.2 Methods

At first, economic feasibility of an A/R CDM project was examined by estimating cost and benefit. The method of project analysis or investment analysis was applied to an A/R CDM project (UNFCCC 2007d). Project analysis was divided into financial analysis and economic analysis. Financial analysis was conducted from the view of an investor, but the economic analysis was from the contribution of the project to national wealth (Gittinger 1982). The benefit of an A/R CDM project was limited to carbon credit. The cost of an A/R CDM project consisted of the ones relating to forestation, activities to organize farmers, transaction activities necessary to formulate, validate, and verify for acquiring carbon credit, which were born by the project promoter in Paraguay. There was no difference in Paraguay between financial and economic analysis, since there was no difference in the benefit and cost generated in the project between them, if no transfer items such as tax, interest, and subsidy were counted, and no opportunity cost of land and labor was applied. In Paraguay, there was no significant value of transfer items in forestation cost. Also, the opportunity cost of land and labor was not relating to transaction cost of A/R CDM project necessary to obtain CER, but relating to forestation cost.

Hereafter, the financial feasibility of an A/R CDM project was examined from the view of the project promoter, taking into account of forestation cost as well as transaction cost. The project cost, which included all the cost necessary for the project, was examined from 2004 to 2013. The cost was not discounted but simply summed up, because the exchange rate between the US dollar and Guarani (the currency of Paraguay) was stable during the project period, and the value of

Japanese yen tended to increase against that of US dollar. The inflation rate of Paraguay was moderate in general, albeit lower in rural areas than in urban areas.

The project cost was divided into local cost and external cost for experts who promoted the A/R CDM project, including the cost for DOE who validated and verified the project. The type of the project cost was classified as 4 cases shown as follows:

(1) Cost from 2004 when the soil conservation project started, to 2013 when the first carbon credit was acquired

The cost of soil conservation project, implemented in the project area from 2004-2006, was included in the cost of the A/R CDM project because the organization of participant farmers and basic data collection on the project area were conducted during the soil conservation project. These organizations and data were used for formulating the A/R CDM project.

(2) Cost from 2006 to 2013

The cost generated from 2006 to 2013 covered the direct cost relating to the A/R CDM project, which formally started in 2006. The cost included the other activities rather than those of the A/R CDM project, such as assisting farmers implement soil conservation work, MIG, trial of MIC, etc. from 2006 to 2013.

(3) Cost from 2004 to 2013 excluding the cost spent for external experts

The cost was assumed as a cost by which the local staff trained and accumulated experiences from the project would implement the soil conservation project followed by the A/R CDM project targeting unorganized communities of SSFs without support from external experts. Validation and verification cost of DOE was included as a minimum external cost.

(4) Cost from 2006 to 2013 excluding the cost spent for external experts

This included cost by which local staff would implement the A/R CDM project targeting unorganized communities of SSFs without support from external experts. The cost for DOE was included.

In addition, the amount of CER (tCER was chosen in this project) as a source of income, either acquired or possible to be acquired by monitoring in 2012, was assumed as 7 cases shown as follows:

(1) CER actually acquired;
(2) CER assumed to be acquired with marginal error less than 10 %;
(3) CER assumed with zero baseline carbon stocks and less than 10 % marginal error;
(4) CER of 2012 planned in the registered PDD;
(5) CER of 2012 with zero baseline carbon stocks in the registered PDD;
(6) CER of 2012 possible to be acquired from the area supplied with seedlings by the project (255 ha), based on the calculation in the registered PDD;
(7) CER of 2012 possible to be acquired from the area 255 ha with zero baseline carbon stocks.

For the reduction of transaction cost, the possibility to reduce the cost was examined according to the results of the A/R CDM project in Paraguay.

For contribution of an A/R CDM project to sustainable development in the project area, 2 questionnaire surveys on participant farmers and one evaluation survey including questionnaire survey for farmers were conducted. The surveys are shown below:

(1) Questionnaire survey on the evaluation of the project in general;
(2) Questionnaire survey on MIG;
(3) Evaluation of the project by MAG including questionnaire survey for farmers.

Questionnaire survey on the evaluation of the project in general was conducted in 2009 by the students of UNA for 36 farm households where every 2 students, 72 in total, stayed at each household for a night for extension training. Those households settled in 6 communities in the project area accepted students voluntarily. The survey was conducted based on the questionnaire prepared by the project promoter.

In 2009, questionnaire survey on MIG was conducted by the project promoter for 30 participant farmers randomly selected among the farmers participated in MIG activities in the project area. The survey aimed to find effectiveness of MIG activities.

Evaluation of the project was conducted by MAG in 2010 as the third party evaluation. The MAG evaluation team set the criteria of evaluation for the project on relevance, effectiveness, efficiency, impact, and sustainability. First the MAG team interviewed 8 personnel responsible for the institutes or organizations relating to the project. Subsequently, the MAG evaluation team selected 40 farmers based on the list of farmers who had been interviewed in 2006 for the third party’s evaluation of the soil conservation project. The questionnaire survey for the selected farmers was conducted for the evaluation of the entire project activities from 2004 to 2010.

For effectiveness of AF, survey on participant AF farmers was conducted in 2011 by the project. Twenty eight AF farmers were selected among the AF farmers who continued AF activity at the time of the survey from registered 80 AF farmers in the PDD. Of the selected farmers, 11 farmers planted *Grevillea robusta* in 2007, and 17 farmers in 2008. The questionnaire included the current state of the AF parcel, land use of the AF parcel to date, and the management plan of the parcel in the future.

The data from the AF plots in the demonstration farm where crop production and tree growth were periodically measured were collected. In AF experimental plot set in the demonstration farm, *Grevillea robusta* was planted in 2007 with spacing of 5 m× 4 m. Production of green manure and food crops between tree rows was continued. In 2011, it was found that the shortage of solar radiation prevented healthy growth of pineapple, banana, and lupine due to the closing canopy.

Experiments to address this problem was conducted by setting two treatments shown as follows: (1) thinning one row of trees and expanding the space to 10 m× 4 m (250 trees/ ha); and (2) raising the pruning rate from 50 % to 70 %, which meant that branches were cut from the bottom to 70 % height of the tree, instead of usual 50 % pruning. Lupine was planted in the space between trees in 3 parts of the AF plot with thinning, hard pruning, and control. Color acetate film (R-3D, Taisei E&L, Tokyo, Japan) was set in multiple points within the experimental parts in the AF plot to measure radiation.

In 2011, a survey of AF practices in other parts of Paraguay was conducted in order to find the most advanced practice of AF in Paraguay. Department of Caazapá (6 farmers) and San Pedro (6 farmers) were selected, because these Departments had the model areas of AF practice supported by “Programa de manejo de recursos naturarel (PMRN)” or Natural resources management project, which has been financed by GTZ for a long time. The project promoter visited and interviewed AF farmers in these Departments, selected by the local offices of MAG.

4.3 Economic feasibility of an AR CDM project

Since this project was the first CDM project registered with the CDM EB in Paraguay, the project promoter had to overcome a number of risks in this frontier. Therefore, the project promoter must have spent large amount of expense and time for various studies, surveys, experiments, documentation relating to participant farmers, and administrative procedures.

Summary of the forested area for CER and the amount of CER on 7 cases set according to actual and assumed conditions of CER calculation (Section 4.2) is shown in Table 4.1. The cost per unit CER for 4 cases set according to classification of realized project cost (Section 4.2) is shown in Table 4.2.

Table 4.1. Forested area for CER and amount of CER in 7 cases

Items	CER actually acquired	CER assumed to be acquired with marginal error less than 10 %	CER assumed with zero BL[a]	CER of 2012 planned in the PDD	CER of 2012 with zero BL in the PDD	CER of 2012 possible from the area supplied with seedlings	CER of 2012 possible from the area supplied with seedlings with zero BL
Forested area for CER (ha)	81.51	81.51	81.51	215.16	215.16	255.70	255.70
Amount of CER (tCO_2)	6,819	7,460	10,682	23,538	32,275	27,973	38,356

[a] BL: baseline carbon stocks

Table 4.2. Cost of the A/R CDM project per CER in 4 cases of cost and 7 cases of CER amount (unit: USD/ tCO_2)

	Item	CER actually acquired	CER assumed to be acquired with marginal error less than 10 %	CER assumed with zero BL	CER of 2012 planned in the PDD	CER of 2012 with zero BL in the PDD	CER of 2012 possible from the area supplied with seedlings	CER of 2012 possible from the area supplied with seedlings with zero BL
1	All cost from 2004 to 2013 used for soil conservation project and A/R CDM	685	626	437	198	145	167	122
2	All cost from 2006 to 2013 for A/R CDM	488	446	312	141	103	119	87
3	All local cost from 2004 to 2013 with DOE cost	214	195	136	62	45	52	38
4	All local cost from 2006 to 2013 with DOE cost	145	133	93	42	31	35	26

The actual CER obtained from the monitoring in 2012 should be considered as the minimum amount, because of the overestimation of baseline carbon stocks and the exclusion of the forested parcels with poor growth. From Table 4.2, a CER price USD 685/ tCO_2 would be required in order to cover all the cost of the soil conservation project and the A/R CDM project targeting unorganized SSFs in a low income rural area of Paraguay by the first carbon credit only. The necessary CER price would decrease to USD 122/ tCO_2, if the following conditions were satisfied: (1) the overestimated baseline carbon stocks were set to zero; (2) the entire area provided with seedlings was included in the A/R CDM project; and (3) the planted trees were grown as planned. The price reduced further to USD 87/ tCO_2, if the cost was limited to the A/R CDM project only.

The objective of this project has not been achieved without external experts or research staff from foreign countries, because this was the first A/R CDM project in Paraguay. Therefore the cost was high compared to usual social forestry projects targeting SSFs. On the other hand, in this project, local staffs were trained in practical jobs of the project during the project period. Guidelines and manuals for soil conservation and A/R CDM project were prepared by the project. It could be possible hereafter to reduce the external cost of a similar A/R CDM project to the minimum through implementing an A/R CDM project by local staffs only. The results of the project indicated that USD 31/ tCO_2 of CER price could cover the cost from formulation of an A/R CDM project to acquiring the first CER, if the cost was restricted to local costs except expenses of the DOE. In this case, the activities prior to formulation of an A/R CDM project were assumed to be reduced significantly by selecting project area where community members were well-organized. Further, the second and subsequent A/R CDM project could reduce costs by alleviating the cost necessary for research, experiments, development of documents specific to an A/R CDM project, and somewhat bypassing administrative procedures that the first project promoter experienced.

The estimation was based on the precondition that the carbon was accumulated in the forested area as planned by the A/R CDM project. If drought, cancellation of farmers, and increase of poor growth parcels occurred, the cost would jump to near USD 100/ tCO_2. The shortage in funds of the project promoter could cause suspension or elimination of the project without getting even one tCO_2 of CER.

Considering the transaction cost of the A/R CDM project, its amount could contribute to add nearly 100 ha of forestation, if the unit price of CER is set as USD 31/ tCO_2 to cover the project cost from formulation of the A/R CDM project to acquiring the first CER. The benefit of a simple forestation project involving smallholders could be regarded as 1.4-1.5 times larger than that of the A/R CDM forestation in Paraguay.

The discussion above did not take into account the return of carbon credit to the farmers. If the benefit of an A/R CDM project e.g. USD 20/ ha/ year was provided to the project area as a rural development fund, similar to an example in Mexico (Chomitz et al. 2006), the necessary premium value of CER would be calculated in 7 cases of CER amount as shown in Table 4.3.

Table 4.3. Premium of CER unit price necessary to ensure USD 20/ ha/ year return of the benefit of the A/R CDM project to the project area (unit: USD/ tCO_2)

Fund necessary for rural development	CER actually acquired	CER assumed to be acquired with marginal error less than 10 %	CER assumed with zero BL	CER of 2012 planned in the PDD	CER of 2012 with zero BL in the PDD	CER of 2012 possible from the area supplied with seedlings	CER of 2012 possible from the area supplied with seedlings with zero BL
USD 20/ ha/ year	1.20	1.09	0.76	0.91	0.67	0.91	0.67

Note) Precondition is that the forestry CER would be issued every 5 years with the same amount of the first CER.

If USD 20/ ha/ year of rural development fund was provided to the project area depending on the forested area, a premium of USD 0.7-1.2/ tCO_2 would be necessary to add on the CER price.

The cost equivalent CER price was estimated from the total cost of project development and transaction cost including monitoring cost incurred till the acquisition of the first CER. The transaction cost of the second and subsequent CER was monitoring cost and DOE cost only, if risks such as changes in management policy of farmers due to generation change, tree pests and disease, and forest fire were not considered.

As for the benefit of the A/R CDM project, an international value of CER was applied. For the A/R CDM project in Paraguay, a CER price necessary to cover the activities for the project period (20 years) was calculated by assuming that the project was developed and managed in the most economical way. It was assumed that the project staffs who were trained and accumulated experiences in the process of the project could implement the A/R CDM project by themselves with little support from external human resources. The baseline carbon stocks were assumed as zero, and the growth scenario of the registered PDD was used. In economic analysis, the benefit of not only tangible but also intangible ones such as soil and water conservation, wind breaking, improvement of environment, etc. were counted in forestation activity in general. However, the intangible benefits except carbon sequestration should be treated as benefits of forestation, not the benefit of the A/R CDM, because the benefit of A/R CDM project was quantified as intangible mitigation of global warming by regarding the growth of trees as an increase of carbon removals.

If the discount rate was set at 3 % determined by the assumed interest rate for long-term bonds in Annex I countries (Morera et al. 2007, Derwisch et al. 2009), the unit price of CER became USD 18.98/ tCO_2 to balance the cost for 20 years of the project period. The cost consisted mostly of transaction cost and production cost of seedlings, where the return to the project area was not included. This CER unit price was similar to the total project implementation cost of the Cao Phong A/R CDM project (USD 19.1/ tCO_2) that targeted smallholders to forest communal land in Viet Nam (Yamanoshita 2012).

This indicated that the A/R CDM project involving smallholders in low income rural area was unfeasible, even if the project was implemented in the most economical way, due to low forestry CER unit price, whose value would expire after the time limit came and usually traded at USD 3–5/ tCO_2 before 2012.

4.4 Reduction of transaction cost

In order to implement the project efficiently, the project promoter conducted awareness raising activity for farmers in the project. The cost of labor and local materials for forestation was saved by BPP established in the project area. However, the reduction of transaction cost was difficult, especially the cost for validation and verification conducted by DOE and almost fixed.

There were factors to increase transaction cost in Paraguay as shown below:

(1) Clarification of land rights;
(2) Low income requirement for small-scale A/R CDM methodology;
(3) Modest carbon benefit due to overestimation of baseline carbon stocks to cover a part of high transaction cost.

For clarification of land rights, plenty of smallholders did not have legal rights to the lands where they settled. The clarification of land rights in accordance with the rule of A/R CDM projects was a considerable burden for project promoter. In addition, there was possibility that the farmers who made the clarification of land rights at the time of registration cancelled participation in the project during monitoring period.

For the small-scale A/R CDM methodology, the declaration that the project was implemented by low income communities and individuals as determined by the host Party should be issued from the host country (UNFCCC 2005b). In Paraguay, DOE requested for the project promoter to obtain DNA's low income declaration. That made the project promoter spending 1.5 years.

For modest carbon benefit, the overestimation of baseline carbon stocks disturbed the project promoter from obtaining considerable carbon removal. When a work to define the project boundary started by paying attention to the wishes of farmers, most of them requested for the project promoter to forest their degraded land dotted with shrubs and native trees. If shrubs and trees exist, reduction of CER due to increase of baseline carbon stocks would follow. The cost to survey existing vegetation, as well as time to spend on the survey, also increased.

On the other hand, transaction cost was somewhat reduced by the followings:

(1) Collaboration with public institutes and national university;
(2) Development of local experts;
(3) Implementation of pre-monitoring.

In Paraguay, an agreement for the collaboration with MAG, UNA, and the project promoter was signed at the start of the project. MAG assisted to introduce the project promoter to low income communities in the project area. UNA was entrusted by the project promoter to implement baseline surveys including socio-economic survey, basic experiments relating to basic wood density and growth scenario, monitoring activities and so forth. Additionally, UNA developed human resources by facilitating student participation in the project. The collaboration with these institutes reduced the cost for organizing farmers and that of various surveys necessary for promotion of the project.

Human resource development for A/R CDM projects has been implemented in various programs particularly held by UNFCCC, though the system of A/R CDM project could not be mastered in short-term training. During the project period, local staff hired by the project accumulated experience and knowledge of the mechanism, and became experts in Paraguay. Their contribution made the project promoter solve issues relating to the project and save cost in both socio-economic and scientific activities.

Monitoring system, which was planned in a PDD, would be found inappropriate after pre-monitoring. The pre-monitoring, conducted in Paraguay to check the monitoring plan, clarified the problems of high growth difference not only among forested parcels but also in the same parcel in the project area. Importantly the system of QC/ QA was found not working. These problems required a fundamental review of the monitoring plan. Unless pre-monitoring was conducted, there would appear delay and cost increase in formal monitoring activity.

4.5 Contribution to sustainable development in the project area

The students of UNA conducted a questionnaire survey to 36 farmers pertaining to project activity at the request of the project in April 2009. This survey was conducted as an evaluation by the third party. The questionnaire was prepared by the project. The results of the survey are shown as follows

(1) Present situation of farm household

Average family size was 4.7, consisting of 3 households less than or equal to 2 members. Trends indicated that young members went out to seek work, and that the number of old people increased. Average owned land area was about 11 ha, including cropland 4.3 ha, grassland 2.7 ha, and fallow land 4.0 ha. Previously fallow land was left alone without any activities. After the start of the project, increasingly farmers cultivated green manure such as lupine and oat in winter.

(2) Production

The area of 2.8 ha per household corresponding to two thirds of cropland was allocated to production of food crops (cassava, maize and poroto beans). Cotton was produced as a main cash crop, followed by sugar cane, vegetables and pineapple. Market for crops was not established. Some groups shipped onions to the center of municipality. Fruit trees, citrus, banana, and mango were grown for self-consumption. On average 2 steers were raised for plowing, and also on average 2.4 cows were owned. Three farmers did not own cattle. An average of 2.4 heads of pigs, and other small animals like chickens, rabbits, etc. were raised.

(3) Forestation

Farmers who participated in the A/R CDM project were 26, corresponding to 72 % of the surveyed farmers. Native trees were planted by some farmers outside of the forested area with *Eucalyptus sp.* and *Grevillea sp*. Sixteen farmers introduced AF, corresponding to 62 % of forested farmers. AF was applied to not only *Grevillea sp.* forest but also to *Eucalyptus sp.* forest. About 80 % of the farmers who introduced AF planted maize between tree rows. As for the effect of AF, 5 farmers (31 %) experienced an increase in yield, 10 farmers (63 %) had no change, and one farmer did not reply. It was unclear whether AF contributed to yield increase, but at least it did not lead to yield decrease. In addition, farmers had an average of 108 native oil palms per household, and sold the palm fruits to the staff of an oil mill visiting communities by truck to buy the fruit collected by farmers.

(4) Use of green manure

All the interviewed farmers except one farmer who didn’t answer introduced green manure. In summer, pigeon pea (91 %) and mucuna (74 %) were planted with food crops. In winter, lupine (51 %) and oat (23 %) were planted. As for effect of green manure, 69 % of farmers replied that the soil fertility was improved, and 20 % recognized as somewhat improved. Only two farmers said no effect was found. The increase rate of crop production with green manure was 64 % on average for the 24 farmers who replied they had a percentage yield increase.

(5) Soil conservation work

Thirty farmers undertook soil conservation work (80 %), whereas 5 farmers did nothing, and one farmer did not answer. As for soil conservation work, farmers grew hedges (57 %), did contour cultivation (37 %), and contour cultivation with hedges (33 %) (multiple answers permitted). For the effect of soil conservation work, 77 % of farmers replied that the measures were useful to prevent soil erosion, and 10 % of them replied that it was useful to some extent. No farmer replied they were ineffective.

(6) Effect of the project

For the rural development effect of the project, farmers replied that the project contributed to crop production (56 %), livestock production (56 %), fruit production (19 %), and training in handicrafts (19 %).

(7) Evaluation of project activities

Among the interviewed farmers, 28 farmers (78 %) participated in soil conservation activities during the project, and the remaining 8 farmers participated only in the A/R CDM project. More than half of the farmers (61 %) replied that the project was effective, followed by 31 % of them who believed that the project contributed to improvement of livelihood to some extent. Only one farmer did not recognize the benefit of the project. For the future, many farmers (26 households, 72 %) expected technical assistance from the project followed by provision of seeds such as green manure (39 %), and micro credit (19 %), etc. (multiple answers permitted).

For MIG activity, the project promoter conducted questionnaire survey for 30 farmers in 2009. MIG began in 2006 to realize part of the farm plan prepared by the individual households and continued until 2013, though the activity from 2011 to 2013 was in a limited scale. MIG was established as a micro project that would become the first step in diversification of production and income generating activities, together with activities that would promote the recovery of land fertility. Many farmers participated in MIG every year.

The results of the survey are shown as follows.

(1) Contents of MIG activities

The MIG activities farmers participated in were control of leaf cutting ants (29), home garden (28), grafting (20), cooking stove (18), and fish farming (4) in descending order. Since few women (2) responded to the questionnaire, the activities for women such as handicrafts, cooking, and raising hens have been underestimated.

(2) Benefit of MIG

All the interviewees replied that the MIG activities were effective. Asked to grade the effect using 5 classes (excellent, good, ordinary, poor, and very poor) in individual activities, 85 % of farmers replied excellent, followed by good, and ordinary. One farmer who participated in fish farming replied with poor (Table 4.4).

Table 4.4. Evaluation of MIG activities (unit: number of answers, %)

Activity	Excellent	Good	Ordinary	Poor	Very poor
Control of ants	29	1			
Home garden	26	1	1		
Cooking stove	15	4	1		
Grafting	4	1	2		
Rabbit raising			1		
Fish farming				1	
Total	74	7	5	1	
Percentage (%)	85	8	6	1	

Note) Number of respondents: 30. Multiple answers were allowed.

The average payment per MIG activity by farmer ranged from Guarani 4,000[5] for home garden to Guarani 30,000 for control of ants. The most expensive activity was cooking stove with Guarani 80,000 per farmer. All the participant farmers responded that the value of payment was appropriate.

(3) Contribution of MIG to the improvement of livelihood

With respect to the qualitative effect of MIG, farmers were asked to rank the activities from first to fourth according to priority. Priority was divided in 1st: very much, 2nd: much, 3rd: some, 4th: less than expected. The highest effect of the MIG activities was recognized as the contribution to the improvement of food quality, followed by improvement of production (Table 4.5).

[5] Average exchange rate was around 4,500 Guarani/ USD in 2009.

Table 4.5. Contribution of MIG to improvement of livelihood (unit: number of answers)

Item	Priority (number of answers)				Total Number of answers
	1st	2nd	3rd	4th	
Improvement of food quality	17	6	3		26
Improvement of production	8	14	5	1	28
Income increase	4		3	1	8
Diversification of production	1	9	14	1	25

Note) Number of respondents: 30. Multiple answers were allowed.

In September 2010, the evaluation team of MAG conducted the third-party evaluation of this project (Godoy et al. 2010). The evaluation activity including a field survey was carried out in one month. The MAG evaluation team set criteria of evaluation for the project as relevance, effectiveness, efficiency, impact, and sustainability.

First the MAG team interviewed 8 personnel responsible for the institutes or organizations relating to the project. The evaluation results of the relevant organizations are shown in Table 4.6. The results indicated that the project was relevant to the agricultural and environmental policy of the country, and was effective and efficient albeit the insufficient number of project engineers. The impact and sustainability of the project was appreciated as high (87.5-100 %).

Table 4.6. Evaluation results of the project by related organizations

Item	Contents	Satisfied (%)	Unsatisfied (%)	Not known (%)
Relevance	Agricultural policy	100.0		
	Environmental policy	87.5		12.5
	Needs and priority of farmers	62.5		37.5
	Selection of the project area	100.0		
Effectiveness	Achievement of the project	87.5		12.5
Efficiency	Duration of the project	62.5		37.5
	Number of engineers	37.5	50.0	12.5
	Physical input by the project	75.0		25.0
	Appropriateness of cooperation with the related organizations	75.0		25.0
Impact	Applicability to the other area	100.0		
	Dissemination of the project to the outside	87.5	12.5	
Sustainability	Capacity building of personnel of relevant organizations with the participation in the project	100.0		
	Feasibility of similar project after the completion of the project	100.0		

Note) Number of respondents: 8 from MAG (General directorate of planning, and Directorate of agricultural extension), UNA, INFONA, SEAM, Department of Paraguarí, and Districts of San Roque González de Santa Cruz and Acahay. Multiple answers were not allowed.

The MAG evaluation team selected 40 farmers based on the list of farmers who had been interviewed in 2006 for the third party's evaluation of the soil conservation project. The team conducted an interview survey to them for the evaluation of the entire project from 2004 to 2010.

The results of the survey were as follows:

(1) With a sense of satisfaction and pride, 83 % of respondents appreciated the support of the

project for the restoration of soil fertility, forestation, and agricultural production;

(2) Most of the interviewees (83 %) said that they were capable to give guidance and disseminate the experiences and achievements obtained from the project to others;

(3) Most of the respondents (90 %) said that they would apply the techniques of soil conservation and forest management to their land after the completion of the project.

The MAG evaluation team determined the main results of the evaluation as follows:

(1) The relevance of the project was high, because the activities of the project were consistent with the agricultural policy of Paraguay and was also compatible with the needs of farmers in the project area;

(2) The project activities relating to the improvement of production (soil conservation and forestation) were highly appreciated by farmers. The forestation in the parcel within their own land, in particular, was considered as the most important achievement of the project by 95 % of respondents;

(3) Most of interviewees (90 %) were satisfied with the achievement of the project, especially the followings:

- Provision of seedlings for forestation;
- Technical training to farmers and demonstration of techniques in the demonstration farm;
- Technical assistance to individual farmers;
- Visit of project engineers to farmers.

(4) The importance found in the evaluation was that 90 % of the farmers expressed wish to continue the techniques learned from the project even after the completion of the project. The farmers also said that they had the ability to extend the techniques and results achieved on their own land to others. This supported the sustainability and achievement of the project.

By March 2013, 6 years after the start of tree planting in 2007, few farmers did thinning and no farmer obtained cash income from forestation. However, at the interview of the DOE in March 2013, farmers replied that they were satisfied with the forest.

Practically, they were observed to fell several trees as necessary for their own use of e.g. construction material for a hut, fence posts for grazing and home garden, and firewood despite obtaining no cash income from the forest.

4.6 Evaluation of agroforestry

The project promoter assumed that AF was more acceptable to farmers than monoculture forestation in low income rural area. In fact, 80 farmers with 83 parcels (52.35 ha) among the 167 farmers with 240 parcels (215.2 ha) had been included in the registered PDD as AF farmers. As for AF species, *Grevillea robusta* was chosen for the use of timber and furniture, and recommended for farmers to plant 5 m ×4 m (500 trees/ ha). The farmers who planted *Eucalyptus sp.* in degraded grassland used the forested parcel for grazing after trees have grown at around 5 m high, and naturally introducing silvopastoral system (Figure 4.1). Considerable number of farmers who planted *Eucalyptus sp.* in degraded cropland was observed to produce food crops between tree rows.

Figure 4.1. Farmers' agroforestry; cultivation in *G. robusta* forest (left) and silvopastral system in *E. camaldulensis* forest (Matsubara et al. 2010)

Among the farmers who planted *Grevillea robusta* for AF, tree growth at initial stage was poor in many parcels due to drought. Damage to crops by trees was not recognized. However the reduction of crop production was gradually observed in the project area. Crop reduction in the demonstration farm became conspicuous, because the growth of *Grevillea robusta* was excellent.

In 2010, when the project promoter asked leader farmers about the crop production in AF parcels at the meeting of leader farmers, they replied that farmers tended to give up crop cultivation after solar radiation reduced and to use the parcel for cattle grazing, because they were reluctant to cut trees, even for thinning. The leader farmers responded that the period of crop cultivation could be continued for 2-3 years after planting, and if the spacing was 6 m ×4 m, the cropping period would be prolonged to 4 years.

In 2011, the questionnaire survey regarding AF to the 28 AF farmers selected from all the AF farmers (80) was conducted. The farmers indicated the kind of crops produced in the AF parcels from finishing planting *Grevillea robusta* (2007-2008) to the present (2011) as shown in Figure 4.2.

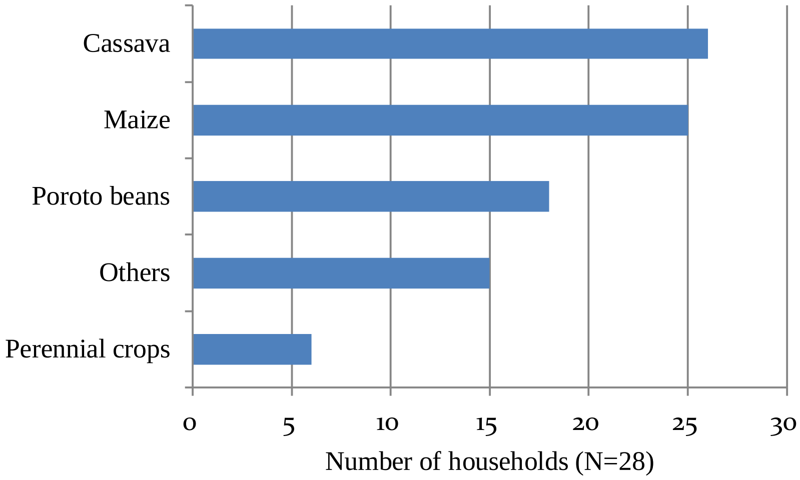

Figure 4.2. Number of households per crop produced in AF parcels from 2007 to 2011. All the crops indicated by farmers, who produced one or more than one crop per year in an AF parcel, were included.

The main crops cultivated in AF parcels were food crops of cassava, maize and poroto beans. Also farmers produced sugar cane, oats, watermelon, green beans, and sweet potatoes in AF parcels, in spite of small amounts. Perennial crops in AF parcels included citrus trees, banana, and pasture. As for the change of crop yield prior to and post forestation, 75 % of farmers reported an increase or no change. Nine farmers (32 %) replied that they would not produce crops in the AF parcels next year, while around 60 % responded they would continue cropping the next year. Of 9 farmers who would stop cropping, 4 farmers replied that the reason for stopping was low solar radiation in AF parcels.

In 2011, experiment to address the shortage of solar radiation caused by closing canopy was conducted in AF plots in the demonstration farm. The plots for the experiment were divided in 3 types: (1) thinning one row of trees and expanding the space to 10 m× 4 m (250 trees/ ha); (2) raising the pruning rate from 50 % to 70 %, and (3) control (500 trees/ ha). Lupine was planted in the space between trees in 3 plots for experiment. Color acetate film was set in multiple points to measure radiation. The average integrated radiation in individual rows is shown in Table 4.7.

Table 4.7. Average integrated solar radiation of each row in *Grevillea sp.* forest (MJ/m^2)

Treatment	Row A	Row B	Row C	Row D	Row E	Row F	Row G	Row H	Average in general
Control with 50 % pruning	18.6	32.0	33.3	30.0	22.0	39.2	25.0	39.1	29.9(± 7.08)
Heavy pruning	22.8	41.5	-	-	-	-	-	-	32.2(± 9.35)
Thinning	-	-	33.5	68.9	61.8	59.4	68.7	50.6	57.2(±12.25)

Note) Standard deviation in parentheses

The integrated radiation of the thinning part was 90 % higher than the control, whereas that of heavy pruning was 10 % higher and insignificant to the control. The weight of beans in a quadrat was measured at harvesting, along with the measurement of stem height of lupine for 2 times during growth. The measurement results of lupine are shown in Table 4.8 (Matsubara et al. 2012).

Table 4.8. Measurement of lupine in the experimental parts of the AF parcel

Treatment	Average stem height of lupine (cm)		Weight of beans of lupine (t/ha)
	14/Jun/2011	30/Aug/2011	
Control	23	85	0.95
Heavy pruning	22	86	1.10
Thinning	22	88	1.30

In the farmer's field, the yield of lupine was assumed to be around 1.3 t/ ha in the project area. The yield of lupine in the thinning part was almost equivalent to normal production in open field. During the growing process, the leaves of some individual lupine became brown or dark brown in thinning and heavy pruning plots, while those in the control plot did not change color. It was assumed that AF would contribute somewhat to prevent crops from frost damage.

In 2011, a survey of AF practices in other parts of Paraguay was conducted. The visited area was Department of Caazapá (6 farmers) and San Pedro (6 farmers). The purpose of the visit was to find the stable and advanced AF system in Paraguay. These 2 Departments had a history to introduce AF for SSFs for a long time.

In Caazapá, AF with fruit trees (agro-fruti-forestal or AAF) was popular, and the area adopted by farmers represented 700 ha. The reason why fruit tree AF was popular was: (1) a juice factory was located there to buy citrus produce from farmers; and (2) the farmers accepted the production system supported by the previous development project (PMRN), which integrated food crops, fruit trees, and timber trees for assuring food security, and generating cash and long-term benefit. The planting system of fruit tree AF in Caazapá was to keep spacing 7 m × 5 m, and plant 2 fruit trees between 2 forest trees. The main tree species were Yvyrá pytá (*Peltophorum dubium*) as native species, and Toona (*Toona ciliata*), Paraíso gigante (*Melia azedarach*), etc. (as exotic species). Most of the farmers, who practiced in the fruit tree AF, continued cropping between trees without problem after establishing the system.

On the other hand, AF farmers in Department of San Pedro tended to give more importance to timber, thus the spacing was narrower than in Caazapá. The farmers in San Pedro were supported by the same rural development project as in Caazapá. The difference was caused by marketability of the product, since the farmers in San Pedro had no access to a fruit processing factory. The practices of AF conducted successfully are shown in Annex 6.

From the experiences in 2 Departments, the followings were found: (1) AF with fruit trees was beneficial for SSFs if the market of fruit products was established; (2) AF which placed importance on timber production was possible if the distance of rows was set at least 6m; (3) the continuity of the system for 7 years was proved in AF of fruit trees with forest density of around 300 trees/ ha, while that of AF for timber production for more than 15 years with forest density of around 800 trees/ ha.

4.7 Discussion

4.7.1 Economic feasibility of an A/R CDM project

The benefit of an A/R CDM project was limited to carbon credit. The cost of A/R CDM project was the ones relating to forestation, activities to organize farmers, transaction activities necessary to formulate, validate, and verify for acquiring carbon credit. Strictly, the cost of an A/R CDM project was limited to transaction cost, which was used for generating forestry CER. Forestation cost which generated benefit of forest and non-forest products should not be included in the cost of an A/R CDM project. Since the following discussion was conducted from the view point of a project promoter, the cost of an A/R CDM project implied all the cost that the project promoter born for an A/R CDM project, including forestation cost.

In Paraguay, aiming to contribute to rural development and generate benefit to SSFs, the project promoter measured the small and dispersed parcels for forestation, conducted various kinds of survey, gave technical assistance and provided seedlings, and advanced every procedure required for an A/R CDM project, with paying attention to the intentions of farmers. This caused inefficiency and high cost, and required 70-80 % extra work more than necessary to establish an A/R CDM project and to obtain first carbon credit. This was due to losing a number of project participants on the way of the project.

In the case of BCF projects, development cost of a large-scale project was around USD 1.50/ tCO_2 (WB 2011b). On the other hand, Malmsheimer et al. stated that “break-even carbon prices (USD/ tCO_2) had 20-fold range depending on the protocol’s rules about baseline values, reversals, leakage and uncertainty”, and “most of the break-even price were far above the best 2010 value for voluntary carbon offsets, USD 10/ tCO_2” (Malmsheimer et al. 2011). In fact, there was an example that in the registered A/R CDM project in Viet Nam the total project implementation cost was estimated to be USD 19.1/ tCO_2 (Yamanoshita et al. 2012).

In Paraguay, the small-scale forested parcels spatially dispersed in the project area made the monitoring cost expensive, in addition to the project development cost. Similar to the case of projects involving multiple farmers who, “for different reasons, may neglect the agreed-upon land-use contract in favor of more desirable alternatives” (WB 2011b), the SSFs in Paraguay conducted different activities for treatment of seedlings, planting, and forest management from instructions given to the farmers by the project. This was one of the reasons why significant difference of tree growth occurred among the participant farmers. The project promoter must have surveyed entire parcels to find good growth with more carbon stocks than baseline carbon stocks, instead of applying sampling survey method. This resulted further in an increase of monitoring cost.

In the A/R CDM project in Paraguay, the project cost including the first monitoring cost as well as project development cost was calculated. In order to make it comparable to other projects, the cost of the project was estimated based on assumption that local staffs who worked for the project with on the job training would implement the A/R CDM project by themselves without external human resources except validation and verification of DOE. If the project was implemented by the local staffs only, and discounted with 3 % of discount rate (Morera et al. 2007) for 20 years of the project period, the break even unit price of CER was estimated as USD 18.98/ tCO_2. For this price, no farmers and communities could gain benefit from the carbon stocks they accumulated.

If the first CER covered the whole cost of the A/R CDM project in Paraguay including the cost of external experts, USD 685/ tCO_2 of unit CER price was necessary. If the rural development was conducted as a part of A/R CDM project using a funding scale of USD 20/ ha multiplied with CER area, similar to the past example of forest carbon project (Chomitz et al. 2006, Jindal et al. 2008), 0.7-1.2 USD/ tCO_2 should be added to the unit price of the first issued CER.

The first issuance of CER should be emphasized, because the project participant could not take long-term uncertain risk of an A/R CDM project involving smallholders. The long-term uncertain risk included not only price fluctuation of carbon credit and natural disasters like drought and forest fires, but also social risks such as change of farmers' intentions caused by generation change, transfer of land rights, change in community structure, and change of project promoter.

The maximum period of A/R CDM projects was 20 years for renewable terms or 30 years for fixed terms (UNFCCC 2005c). In forestry carbon projects, there were examples to pay about USD 900 to farmers over the course of 10 years to keep their land as a woodlot, based on a carbon price of between USD 4.0 and USD 5.5/ tC (USD 1.09 and USD 1.5/ tCO_2 equivalent) (Shames et al. 2013), and to pay USD 30/ ha/ year to conserve existing forests for managing water resources with five year contracts which were conditionally renewable (de la Torre et al. 2009).

The carbon offset price has oscillated between USD 3.8 and 5.5/ tCO_2, and the average volume weighted carbon price in the period 2004–2007 was about USD 4.5/ tCO_2 (Nakakaawa et al. 2010). There was an example that the BCF has bought carbon credits from forestry projects for prices of USD 3.75-4.35/ tCO_2 according to ERPA (Morera et al. 2007).

The instability of carbon market, which was symbolized by the collapse of carbon price in the EU ETS, was a serious issue that shook the foundation of the CDM system. Paraguay also was not free from this instability. The non-permanence of A/R CDM projects limited "the carbon finance's potential to catalyze underlying investment and frontload capital to cover the high upfront capital needs of forest projects" (WB 2011b). The high unit cost per forestry CER of A/R CDM project that targeted smallholders in particular severely limited the participation of private companies or financial institutions.

In Paraguay, the A/R CDM project required more than USD 31/ tCO_2 of the first CER unit price, to cover the whole cost from the start of the project to the acquisition of the first CER, on precondition that the project would be implemented only by local staffs and the waste of resource use for the project was at minimum. The amount of the unit cost was 6 to 10 times higher than the average forestry CER price realized in trading before collapsing CER price.

If the same kind of the A/R CDM project in Paraguay was implemented, input from ODA or public funds would be essential, where the project could not depend on private companies or financial institutions. There were opinions that the use of ODA to A/R CDM was necessary especially for community-based projects (WB 2011b, Yamanoshita et al. 2012), while diversion of ODA to CDM projects was not permitted (UNFCCC 2005a). If ODA was used for the A/R CDM project with high social impact in low income communities which placed sustainable development as an overall goal, then ODA use could be regarded as reasonable, though there were large scale plantation A/R CDM projects clearly ineligible for ODA such as the A/R CDM project in Brazil.

The basic rule was that CERs resulting from ODA-financed CDM projects should be considered as a return to the donor (OECD 2004). If a donor has agreed with the host country not to receive any of the generated CERs, no deduction from ODA flows would be necessary (ibid.). If the host country and Annex I countries of the Kyoto Protocol declared that the ODA being used for an A/R CDM project was an additional grant and the Annex I country never received CER created by the A/R CDM project in return, this ODA would not be contrary to the principal rule of CDM. In order to avoid the application of unrestricted ODA to A/R CDM projects, ODA use should be restricted to transaction cost, training of participant farmers and local staffs, and production of seedlings. In the current situation, capacity development activities which were not directly related to the creation of CER were accepted as an activity to be supported by ODA. The maximum period of activity relating to an A/R CDM project supported by ODA should be from the start of the project to the first acquisition of CER. In Paraguay, the period was 7.5 years. During the period, local staffs were trained sufficiently by OJT, and experiences were accumulated by completing one CDM cycle.

The benefit obtained by selling CER was useful for the project area. In fact, some forestry carbon projects used carbon revenues to invest in local infrastructure improvements or support for local schools (Peskett et al. 2010, WB 2011b). In Paraguay, the project promoter tried several MIC activities in order to confirm possibility to use CER revenue for funding extensive MIC activities. Even establishment of a new cooperative was attempted to manage MIC system appropriately. However, incapacity of fiscal management and poor quality of leadership in the targeting groups of SSFs prevented it from developing into a sustainable micro finance system. In the end, it was decided that the CER revenue would be used for introducing educational equipment to local schools located in each community in the project area.

The time-limited forestry CER had a higher possibility to be used as part of the carbon offset of private companies than used for the purpose of achieving the voluntary emission reduction targets. The characteristics of A/R CDM, that carbon sequestration is visible as tree growth, could be used by private companies to appeal to consumers as their emission reduction activities in an easy-to-understand manner. In addition, the advertising effect of companies, by demonstrating support for forestation in low income rural area as corporate social responsibility (CSR), could be expected (Kankyo-shou 2012).

The results of questionnaire survey for A/R CDM in 2008, responded to by 69 of 178 Japanese companies, revealed that 60-70 % of the companies have been involved in some kind of forest related activities, and for A/R CDM, 6 % of respondents have already participated, and over 70 % of them were at the information gathering stage with regard to participation (Fukushima

2012). The results of the awareness survey of companies and local governments for the Japan's Offset Credit (J-VER) Scheme, which was implemented in 2009 in Japan with responses by 27 local governments and 111 private companies, indicated that the most expected effect of J-VER was “the promotion of forest management” (JREI 2009). Thus, the interest of Japanese companies in forestry CER and forestry J-VER, could be expected to some extent. Especially, the unit price of J-VER was recorded as USD 120/ tCO_2 in 2011 (Peters-Stanley et al. 2011, Kankyo-shou 2012).

If unit price of forestry CER is within USD 3-5/ tCO_2 range, the forestry CER could be purchased as an inexpensive carbon credit by the company having interest to use them for contributing to CSR. However, such a range of CER price prohibited an A/R CDM project. The direct investment in forestation for smallholders was far more economical than the forestation by an A/R CDM project. Van Kooten declared that “while there is no question that carbon can be stored in terrestrial sinks, and that care should be taken to foster such sinks and ensure that carbon is not unwantedly and needlessly released (e.g. via deforestation), this is no reason to justify their inclusion in international agreements to mitigate climate change or in international trading schemes” (van Kooten 2009).

In Paraguay, high unit cost of USD 31/ tCO_2 was necessary even if the most efficient conditions were given, such as zero baseline, project management by local staffs only, and carbon stocks increase more than planned in the area where seedlings were provided without loss. In consideration of the characteristics of SSFs (large number of participants, small and dispersed parcels, and low management capacity), these conditions were unrealistic, thus, higher unit cost than USD 31/ tCO_2 should be necessary to implement an A/R CDM project involving SSFs. Carbon prices have hit the bottom in 2013, then, sign of recovery in the CER price was invisible. There was no economic feasibility in an A/R CDM project involving SSFs.

4.7.2 Reduction of transaction cost

For the implementation of an A/R CDM project, transaction cost was added to the expenses necessary for forestation. The A/R CDM project should be managed in a range of transaction cost to meet the CER revenue, since the purpose of an A/R CDM project was the acquisition of CER. In an A/R CDM project involving smallholders, if there was no existing experience of forestation by farmers, payment to farmers based on the expected CER revenue was made as incentive for forestation. For example in Ethiopia, BCF did the first payment based on sequestered carbon estimated by measuring the actual growth of the regenerated vegetation (Brown et al. 2011), 2 years before issuance of CER. In other words, incentives were regarded as a part of transaction cost of the A/R CDM project. The creation of jobs by forestation was placed as an effect of A/R CDM projects in the PDDs of many large scale A/R CDM projects; however, in an A/R CDM project involving smallholders, the area of forestation was so small that farmers could forest the area by their own labor. In Paraguay, no direct payment was given to farmers as incentive. The participant farmers did land preparation, planting, and sometimes fencing to protect forested area from cattle by themselves. The cost of forestation for the project was limited to production and supply of seedlings together with training of farmers.

The transaction cost of an A/R CDM project has been analyzed since around 2002, based on the results of the pilot forestry projects for carbon credit at that time. As a result, the forestry carbon price has been seen in the range of USD 3-17/ tCO_2 (Salazar et al. 2002). However, transaction cost of A/R CDM projects targeting smallholders was quite expensive compared to the one targeting large land owners. Transaction cost for small ownerships (less than 100 ha) was 10-20 times more costly per offset credit than for large ownerships (Malmsheimer et al. 2011).

Reflecting the A/R-WG's efforts to incorporate feedback from existing projects, the recent versions of methodologies became less complex, however, simplified modalities and procedures "have little effect on improving the viability of small-scale projects" (WB 2011b). In Paraguay, simplified baseline and monitoring methodology for small-scale A/R CDM project was applied, and expected that the transaction costs would be reduced. It did not happen. The methodology simplified the estimation of leakage for preparation of a PDD. However, this did save neither time nor cost, because the project promoter needed to interview all participating farmers who wanted to forest grassland about the number of grazing cattle to be displaced by forestation.

For validation, "DOE's inexperience is reflected in their paying attention to issues that are no longer relevant, inefficient data collection for the assessments, and lack of sound judgment to assess the application of the A/R CDM rules in light of national circumstances" (WB 2011b). In Paraguay, serious overestimation of baseline occurred, due to counting native oil palms as baseline. The carbon stocks in palms were excluded initially from baseline because farmers continued to collect the fruits for cash; however, DOE requested to include them in baseline estimation. The overestimated baseline prevented the parcels with less carbon stocks than baseline carbon stocks from monitoring, resulting in the decrease of number of parcels and amount of CER.

Clarification of land rights was necessary at the time of monitoring, because forestry CER was issued ex-post in accordance with GHG removals by sinks determined by monitoring. However, the land rights were not necessarily needed at the time of registration, when there was high risk not to gain CER, if considering that the probability to acquire forestry CER was less than 20 % of A/R CDM projects reaching validation stage. If the rule was that clarification of land rights should be finished during monitoring, the time and cost required for land right clarification could be decreased by about 80 % in Paraguay.

The accuracy of monitoring of A/R CDM projects was within a confidence level of 90 % with a maximum relative error of 10 % (UNFCCC 2012d). Difference in tree growth among individual forested parcels of farmers will be large for an A/R CDM project involving smallholders. It would be necessary to increase the number of sample plots in order to reduce error. The sample size could not be decided without measuring a number of parcels. In Paraguay, parcels including carbon stocks corresponding to equal to or more than baseline carbon stocks were selected for monitoring. Permanent sampling plots were established in entire selected parcels, and forest survey was undertaken. The standardized appropriate management, as in large industrial plantation, was not performed in most farmers' parcels, therefore the time and cost of monitoring increased.

Considering the transaction cost of the A/R CDM project in Paraguay, its amount could contribute to add nearly 100 ha of forestation, if the unit price of CER was set as USD 31/ tCO_2 to cover the project cost from formulation of the A/R CDM project to acquiring the first CER. The benefit of simple forestation project involving SSFs could be regarded as 1.4-1.5 times larger than that of the A/R CDM forestation in Paraguay, if the same amount of fund for a project was provided.

In order to reduce the transaction cost, the followings were somewhat effective along with establishment of BPP.

(1) Clarify land rights at the time of monitoring.

A lot of land rights established at the validation were of no use for acquiring carbon credit, and the time and cost to obtain land certificates were wasted for the project promoter. If the land rights were clarified only at the time of monitoring, time and cost would be saved.

(2) Elimination of low income requirements for small-scale A/R CDM methodology.

The low income requirement applying only to the methodology of small-scale A/R CDM projects has caused a further increase in transaction cost and delay of the procedures. To be consistent with the CDM rules for projects in other sectors, the low income requirement for small-scale A/R CDM projects "should be removed" (WB 2011b).

(3) Select parcels to be forested with little baseline carbon stocks

In order to avoid decrease of carbon revenue by overestimation of baseline carbon stocks, the lands with scattered woody perennials should be excluded from project boundary, even if the land satisfied eligibility of land required in the methodology.

(4) Collaborate with public institute or university relevant to agriculture and forestry sector

The collaboration with universities, research institutes, and other public entities that were developing land-use-related projects was effective.

(5) Develop local experts by OJT

Local staffs could be trained sufficiently by OJT, and experiences be accumulated during the progress of a CDM project cycle. Those staffs became local experts of A/R CDM projects, who would contribute to reduction of transaction cost in a similar forestry carbon project in future by substituting with external experts.

(6) Implement pre-monitoring

If the monitoring was conducted without pre-monitoring activity, issuance of CER would have been hindered. In order not to increase the cost of monitoring, the monitoring plan should be modified to apply to the actual conditions in the project area, by implementing pre-monitoring activity early after registration.

There were opinions that involving smallholders or communities could achieve high measurement accuracy by allowing sampling intensity at a fairly low cost (Cacho et al. 2003, Skutsch 2005). The experience in Paraguay was contrary to this assumption. Farmers did not understand the importance of accuracy, and caused a lot of errors even if trained sufficiently before the work commenced. If serious errors were found, revisiting the sites and re-measuring would follow to ensure accuracy. That would result in time and cost increase. Monitoring activities by local staff trained by OJT during the project was the most efficient way to ensure precision level of monitoring described in the methodology.

Transaction cost of an A/R CDM project was built in a high cost structure due to institutional methodological issues. Moreover, the essential simplification of the methodologies and procedures has not advanced, rather increased works relating to e.g. assurance of precision level. Method of reducing transaction cost could be considered; however, eliminating the 10 times difference between the unit project cost and the unit carbon revenue of an A/R CDM project involving SSFs would be impossible. It was far more effective if the fund designated to covering transaction cost for an A/R CDM project was used for forestation of SSFs' degraded lands.

4.7.3 Contribution to sustainable development in the project area

The A/R CDM project in Paraguay targeted to low income communities where plenty of SSFs were living with ongoing degradation of land, vegetation and water resources. The project was expected to contribute to the increase of direct and indirect benefit associated with forestation (timber for sale, firewood and wood product for self-consume, prevention of soil and wind erosion, shading for cattle, etc.), as well as the benefit of carbon credit. The support from the company, who would buy carbon credit, was also expected to provide assistance to the project area from the view point of CSR or base of pyramid (BOP) business.

It was said that the experience of BCF projects showed that A/R CDM projects could produce carbon credits "while significantly contributing to improving rural livelihoods and restoring, conserving, and producing other environmental benefits" (WB 2011b). Also, forest was seen "as a security buffer or savings for bad times" for smallholders (ibid.).

It should be noted that the direct and indirect benefit for farmers generated by the project was not the benefit of the A/R CDM project, but the benefit of forestation. The benefit of forestation could be realized if incentive for forestation was exerted, even without A/R CDM mechanism. The benefit of carbon credit for the project participants was obtained only when the CDM project was established in an economically sound manner.

The framework of A/R CDM was determined in 2003 by COP9, followed by establishing the first A/R CDM methodology in 2005, and registering the first A/R CDM project in CDM EB in 2006. However, the CER of A/R CDM projects have not been issued until April of 2012, before which forestry carbon credit was traded in voluntary carbon market. Additionally, forestry CER was placed in a disadvantageous situation due to exclusion from the EU ETS, which was the backbone of the EU's climate policy and the engine of the global carbon market (WB 2012). In 2011, 315 million CER were issued, which was 140 % increase over 2010 (ibid.). Toward the end of the first commitment period, the oversupply of CER became outstanding (UNFCCC 2013b), and caused the downward trend of the CER unit price. Entering 2013, the price of carbon credit has fallen to "rock-bottom levels" (WB 2013a).

Locatelli et. al stated that "if CER prices increase, the price of tCERs would be lower and the tCER method would be less profitable for the project" (Locatelli et. al 2004). Conversely if prices of permanent CER decreased over time, the value of non-permanent CER would rise. Morera et al. stated that "if the growth rate of permanent CER prices is higher than the interest rate, non-permanent CER has no value and the whole system of trading temporary or long-term emission offsets would fail" (Morera et al. 2007). The present lowest level of permanent CER price, therefore, was not so much different from forestry non-permanent CER. However, economic feasibility was nil with too low a CER price, even needless to confirm the financial balance of CDM projects.

The KP aimed to promote sustainable development (UN 1998). Forestation was a project that required a long period of time, however, if proper forest management was achieved in 2 or 3 years after planting, most trees grew without extra effort thereafter. In Paraguay, it would take 12 years for *Eucalyptus sp.* and 20 years for *Grevillea sp.* to be ready for harvest, thus the forestation itself was sustainable with a long period. When it came to the acquisition of carbon credit, which was the foundation of CDM projects, things were different.

The monitoring activity of A/R CDM projects should be carried out every five years after the initial verification and certification undertaken at a time selected by the project participants (UNFCCC 2005b). In the blank period of five years up to the following monitoring, risks such as generation change in beneficiary farmers, the transfer of land ownership by the farmers, as well as change of project personnel, dilution of relationship with farmers by decreased visiting opportunities were likely to occur in the project where smallholders participated. Reluctance of farmers to cooperate with the project for monitoring could be assumed unless adequate explanation was provided again in the case of e.g. generation change, since the CDM system was unfamiliar to farmers. It would be necessary to succeed in the first monitoring, and to show participant farmers how the benefit of carbon credit was used appropriately for the communities. The cheap CER of A/R CDM could not even cover the monitoring cost and verification expenses. Even if farmers cooperated in the project, it would be doubtful whether the project could acquire carbon credit continuously.

As a requirement of sustainability for A/R CDM projects, the capacity building of local people was emphasized (WB 2011b). In Paraguay, the result of the evaluation conducted by MAG indicated that 83 % of respondents (33/ 40 households) expressed that they were capable to give guidance and disseminate the experiences and achievement gained from the project. The confidence of farmers was considered to be established by the close relationship between the project promoter and farmers, built from the formulation of the project to pre-monitoring activities. It took 5 years (2006- 2010) to find the confidence of farmers for the project. This showed that five years would be required for a project promoter to continue activity of capacity building in communities, if expecting sustainability of project achievement.

For SSFs, receiving seedlings and training from the project promoter on their own initiative was effective for securing sustainability of forestation in their lands. Sustainability of forestation was high, though the effect of an A/R CDM project (or effect of carbon benefit) was nil. If carbon revenue exceeded transaction cost, the net benefit could be used for MIG or MIC as a fund for community development; however, there was no possibility to obtain net carbon benefit at present. In other words, forestation contributed to the improvement of SSFs' livelihood and environment in communities, but an A/R CDM project (or forestry carbon project) did not contribute to sustainable development in the project area at all.

4.7.4 Effectiveness of agroforestry

SSFs in Paraguay practiced rotation farming with food crops in principle, cash crops, and grazing or fallow, applying small amount of input (fertilizer, agricultural chemicals). The land proposed to be forested was unused land or low use with degraded soil fertility. The project promoter recommended AF to farmers to leave the land possible for agricultural use even with degradation, not to leave it only for long-term forestation. The adoption of AF was decided by farmers. Eventually, 80 farmers with 52 ha, planted tree seedlings in their land for AF. Place et al. stated that the importance of smallholder agroforestry was only likely to be reinforced to climate change adaptation and mitigation (Place et al. 2012). In addition, FAO regarded AF as "an essential component of global efforts" both to enhance rural livelihoods and to mitigate climate change (FAO 2012b).

The number of parcels of AF, which accumulated more carbon stocks than the baseline carbon stocks in 4-5 years after tree planting activity, was only 6 in Paraguay out of 83 in the PDD. The volume of net anthropogenic GHG removals by sinks was 5.6 tC on 4.99 ha (1.12 tC/ ha). It was difficult to obtain a substantial amount of CER in the AF parcels in the first monitoring event. The second and subsequent monitoring, occurring every 5 years, would be uncertain due to the risk of natural and socio-economic change; thus, less carbon revenues than expected would be obtained from AF in future. The profitability of an A/R CDM project including AF would deteriorate more than that of monoculture fast growing plantation A/R CDM project. If cash crop trees like fruit trees were introduced, as viewed from the example of Paraguay, the farmers, not the project promoter, could obtain more benefit than conventional timber AF.

The survey results from AF farmers indicated that the AF of *Grevillea robusta*, planting with spacing of 5 m × 4 m (500 trees/ ha), could produce crops without damage for 2-3 years after planting, when the trees grew well. The AF model tried in the A/R CDM project in Paraguay could be sustainable by thinning one row to change forest density of *Grevillea robusta* from 500 to 250 trees/ ha if the canopy was closing to affect crop production. The forest density of 125 trees/ ha would be the final stands when the growth of trees were too fast to damage crop production after the forest was thinned to 250 trees/ ha. If appropriately thinned, it would be possible to extend the duration of AF.

In addition, the possibility of mixed planting of agricultural crops, timber trees and fruit trees was confirmed. Farmers who planted *Eucalyptus sp.* in degraded grassland used the forested parcel for grazing after trees have grown at around 5 m high, and naturally introducing silvopastoral system. Since large degraded grassland extends everywhere in Paraguay, the potential of silvopastoral system would be high. If forestation was conducted on the land where soil fertility was excessively decreased, sound growth of trees could be expected by intercropping green manure such as *Canavalia ensiformis* and *Cajanus cajan* between trees at the initial stage of forestation. Field experiment suggested that if green manure and cattle dung was applied late in forestation, the effect to the growth of *Eucalyptus sp.* would be negligible.

AF was beneficial for farmers to use their own land spatially. If proper management like thinning was conducted in a timely manner, AF would be established as a sustainable farming system. Moreover, there was high potentiality of silvopastral system in the South America, where vast forest land has rapidly been converted to grassland to graze cattle. Nonetheless, unit CER amount per area generated in AF parcels was smaller than that of monoculture forest parcels; thus, the economic feasibility was deteriorated further. AF should not be promoted as a part of an A/R CDM project, but as a part of forestation for SSFs.

5 General discussion and conclusion

5.1 Current situation of A/R CDM projects

Simplification of A/R CDM system was required because disadvantage derived from characteristics of forestry led to low carbon price, to difficulties to estimate carbon stocks increase, and to increase of long-term risks of the project.

Practically the present simplifications applied to small-scale A/R CDM projects had little effect on reduction of transaction cost (WB 2011b). The issuance of the low income declaration necessary for small-scale A/R CDM projects increased the cost of administrative procedures, which traded off a part of cost reduction derived from methodological simplification. Project promoters were likely to establish a project in a limited time frame. This explained the A/R CDM projects targeting the lands of smallholders were usually small-scale, because they needed to restrict project area and number of participants to keep the time frame.

Excessive simplification had risk to lower the reliability of the issued carbon credit. Therefore, priority should be placed on streamlining institutional difficulties, which were unrelated to the estimation of carbon stocks but disturbed smooth implementation of A/R CDM projects.

From 45 projects registered with the CDM EB by the end of the first commitment period, A/R CDM projects were found that: (1) they were implemented regionally well-balanced; (2) percentage in number of small-scale A/R CDM projects contributing social forestry was higher than that of large-scale projects; (3) high rate of participation of public institutions; (4) almost all the projects planned on public land or communal land aimed at social forestry; (5) exotic species were preferred to native ones; (6) percentage of AF was high in Latin America, but not outstanding in general; (7) payment to farmers or farmer groups was likely prevalent as an incentive for planting; and (8) the weight of support from the BCF was large for financing the projects.

The results above showed that: (1) the applicability of A/R CDM system was extensive enough to be adopted in every region of the world; (2) the high social benefit was expected because of high participation rate of public institutions and public lands provided for forestation, including possibility of direct payment to the participant farmers, in spite of relative smallness of the social forestry project; (3) exotic species had priority to earn CER efficiently; (4) AF had been limited where forestation was implemented in private lands in e.g. LACs; (5) the role of public finance was high due to low profitability of A/R CDM projects.

5.2 The A/R CDM project in Paraguay

The five issues raised for the A/R CDM projects involving smallholders were examined through analyzing the whole implementation process of the A/R CDM project in Paraguay.

First, the solution of issues to realize an A/R CDM project was examined. In Paraguay, the technical difficulty such as land eligibility and estimation of carbon stocks (baseline, project scenario, and leakage) was solvable by the objective assessment of the local situation through various on-site studies, though these required high cost and long time. However, the decisive was social and institutional issues such as organizing and facilitating farmer participation in the project, creating agreement between the project promoter and individual farmers, clarifying the rights relating to land, and passing through the procedures of DNA. These issues determined feasibility of the A/R CDM project. The following experiences of the A/R CDM project in Paraguay would serve as a reference to address these issues:

(1) Organizing project participant farmers by community participation approach placing importance on raising awareness of farmers;
(2) Entering into an agreement with individual farmers to determine the distribution of costs and benefits related to forestation, the project promoter had all the benefit of forestry CER, while the farmers could take all the direct benefit from tree sale and products from the forested land. For bearing the forestation cost, the agreement was that the participant farmers provided labor for forestation based on BPP, whereas the project promoter provided training and seedlings for free. This was different from the conventional forestation project where aid agencies made payment to smallholders as an incentive for planting and management of the planted land for several years;
(3) The certificates of land occupation from INDERT, used as a sub-legal demonstration of land right, were acquired to the farmers for whom seedlings were provided. Finding easier method was important to solve time consuming and high-risk difficulties relating to land right clarification;
(4) The problem of insufficient capacity of DNA appeared to delay the proceedings. The delay of DNA procedures increased the uncertainty of the project, and led to an increase in transaction costs. The A/R CDM procedures should be reformed to reduce the commitment of DNA to the project as little as possible;
(5) The performance of SSFs was insufficient to acquire CER in the A/R CDM project in Paraguay. The number of participant farmers and area of forestation for CER decreased from 325 farmers with 301.2 ha in 2006-2007 to 56 farmers with 81.51 ha in 2012 when the first monitoring was conducted. The time and expense spent for the cancelled parcels were wasted. When compared the amount of issued CER with the number of farmers who contributed to the issuance of CER, the share of 7 farmers having more than 2 ha of forested parcel was around 72 % in the total CER. The poor performance of SSFs led to high cost of monitoring due to low and irregular growth of trees in their parcels. If feasibility of an A/R CDM project involving SSFs was examined, high loss rate which would lead to more than 50% should be considered.

It was obvious that the forestation project targeting large number of SSFs was more costly than the project targeting small number of middle/large-scale farmers. Acquisition of CER from an A/R CDM project involving SSFs by solving difficulties was possible if capability of the project promoter as well as sufficient time frame and funding were ensured; however, the inefficiency to target SSFs would not be essentially solved.

Second, the economic feasibility of an A/R CDM project was examined. Inefficiency and high cost of the A/R CDM project involving SSFs resulted in 70-80 % extra work more than necessary to establish an A/R CDM project and obtain the first CER in Paraguay. A CER price of more than USD 31/ tCO_2 was required in order to implement A/R CDM project locally in Paraguay without external assistance and to cover all expenses through the first carbon credit. The high unit cost per A/R CDM project that targeted smallholders severely limited the participation of private companies or financial institutions. If the same kind of the A/R CDM project as in Paraguay was implemented, funding from ODA, public funds or international development financing institutes would be essential. On the other hand, the CER unit price was far below USD 3-5/ tCO_2 assumed before 2012. Carbon prices have hit the bottom in 2013, then, sign of recovery in the CER price was invisible. There was no economic feasibility in an A / R CDM project involving SSFs.

Third, reduction of the transaction cost of an A/R CDM project was examined. The possibility to reduce transaction cost of A/R CDM project involving smallholders was small, due to complexity of organizing smallholders, collecting data and documents from smallholders, and satisfying demanding methodological requirements to address uncertainty relating to biological carbon. The simplified A/R CDM methodology did not lead to reduction of transaction cost. The amount of the transaction cost could contribute to add nearly 100 ha of forestation, if the unit price of CER was set as USD 31/ tCO_2 to cover the project cost from formulation of the A/R CDM project to acquiring the first CER in Paraguay. The forestation activity based on BPP, which was established in Paraguay, resulted in reduction of the cost necessary for labor work and local materials such as land preparation, foresting, and sometimes fencing to protect forested area from cattle, which were provided by participant farmers. In order to make an A/R CDM project efficient along with forestation based on BPP, it was important to: (1) select parcel to be forested with little baseline carbon stocks; (2) clarify land rights only at the time of monitoring, not at validation; (3) eliminate low income requirements for small-scale A/R CDM methodology; (4) collaborate with public institute or university relevant to agriculture and forestry sector; (5) develop local experts by OJT; and (6) implement pre-monitoring. However, eliminating the 10 times difference between the unit project cost and the unit carbon revenue of an A/R CDM project involving SSFs would be impossible. It was far more effective if the fund designated to covering transaction cost for an A/R CDM project was used for forestation of SSFs' degraded lands.

Fourth, contribution to sustainable development in the project area was examined. The direct and indirect benefit for farmers brought by the project was not the benefit of the A/R CDM project, but the benefit of forestation. Even if farmers cooperated in the project, it was doubtful whether the project could acquire carbon credit continuously due to uncertainty of natural disasters and change of land tenure or generation. In Paraguay, the result of the evaluation indicated that 83 % of respondents expressed that they were capable to give guidance and disseminate the experiences and achievement gained from the project. Continuity of project activity including capacity building in communities for at least 5 years was essential to establish confidence of farmers. If carbon revenue exceeded transaction cost, the net benefit could be used for MIG or MIC as a fund for community development; however, there was no possibility to obtain net carbon benefit at present. In other words, forestation contributed to the improvement of SSFs' livelihood and environment in communities, but an A/R CDM project did not contribute to sustainable development in the project area at all.

Fifth, effectiveness of AF was examined. It was difficult to obtain a substantial amount of CER in the AF parcels in the first monitoring event. AF with *Grevillea robusta* (500 trees/ ha) was possible for crop production for 3-4 years without thinning after planting activity, however, the carbon credit amount was too small to cover transaction cost.

AF was accepted by the farmers in the project area, where farmers who planted *Eucalyptus sp.* in degraded grassland used the forested parcel for grazing, and considerable number of farmers who planted *Eucalyptus sp.* in degraded cropland was observed to produce food crops between tree rows. Since large degraded grassland extends everywhere in Paraguay, the potential of silvopastoral system would be high. Nonetheless, unit CER amount per area generated in AF parcels was smaller than that of monoculture forest parcels; thus, the economic feasibility was deteriorated further. AF should not be promoted as a part of an A/R CDM project, but as a part of forestation for SSFs.

Other than 5 issues, the followings were pointed out.

(1) It took a long time and much expense from formulation of an A/R CDM project for smallholders to acquisition of the first CER. In Paraguay, project activity for 7.5 years has been necessary for obtaining a small amount of CER, namely, 29 % of the planned amount.
(2) In order to secure the necessary funds for rural development, 0.7-1.2 USD/ tCO_2 was required to add on the CER unit price e.g. 31 USD/ tCO_2 of the least necessary price.
(3) The current CER price in the carbon market was extremely low, so an A/R CDM project was unfeasible. This implied that rural development applying A/R CDM mechanism was also unrealized. Forestation projects for smallholders without carbon credit should be promoted in order to save time and cost.

Moreover, if the UNFCCC intended to promote A/R CDM projects in the future, it would be required to simplify further the system and methodology of A/R CDM projects to reduce the burden on project promoters, with the assumption that the CER price remained at a low level. In particular, amendment of the rules which would not decrease the quality of CER should be promoted as soon as possible, e.g.: (1) making institutional reform that ODA could be used for A/R CDM projects under certain conditions; (2) eliminating unnecessary provision (e.g. the low income requirement for small-scale A/R CDM projects); and (3) no requiring excessive clarification of carbon rights and land rights at the validation stage.

5.3 Effectiveness of an A/R CDM project

The A/R CDM project in Paraguay had the characteristics of the A/R CDM projects registered with the CDM EB. In other words, this project was a small-scale A/R CDM project that had high social value, including the participation of public institutions and introduction of fast-growing exotic species. AF popular in LACs rather than in other regions was also conducted in the project in Paraguay. The sequestrated CO_2 amount per unit area in Paraguay was 16.73 tCO_2/ ha/ year (6,819 tCO_2/ 81.51 ha/ 5 years), which was near the world planned average for small-scale A/R CDM projects.

On the other hand, communal land and state-owned land were not included in the project in Paraguay unlike the majority of social forestry A/R CDM projects. The forestation of communal lands has been requested initially, whereas the planting activity was not conducted. This was because the management system of communal land was unclear, and no community member dared to plant on the land, from which nobody had clear right to get forest benefit.

The payment to beneficiary farmers, popular in other A/R CDM projects, was also not made in Paraguay. Since the BPP had been established before foresting activities, the farmers planted seedlings in their land without receiving payment from the project.

The objective of the study was to verify the hypothesis that a carbon benefit obtained from the A/R CDM involving smallholders improves the lives of smallholders, by examining three premises that: (1) CER could be issued from an A/R CDM project involving smallholders; (2) carbon benefit could be obtained by selling CER to buyers at the price greater than the transaction cost; and (3) participant smallholders could obtain benefit from the A/R CDM project.

For the first premise, the issue relating to solving issues to realize an A/R project was proved possible in the A/R CDM project in Paraguay. The process aimed at the acquisition of CER was set and passed through by the project promoter. The institutional requirements especially clarifying land rights and CER tenures were solved by obtaining sub-legal certificates of land occupation from the governmental institute and having agreements with all the participant farmers individually. Proper participatory approach focusing on awareness raising of farmers was successful and the farmers agreed to bear cost of labor and local materials for forestation.

For the second premise, the economic feasibility and possibility to reduce transaction cost of an A/R CDM project were examined. The project in Paraguay was intended to have a threshold scale of more than 300 ha plantation. Actually, the scale of project was 215 ha at the registration, thereafter reduced to 82 ha at the monitoring for CER acquisition. The cost for field works and procedures became high due to necessity to target plenty of beneficiary farmers. The large difference of tree growth in the project area was found mainly due to the difference of performance among farmers and attack by natural disaster of drought. The relatively excellent tree growth in middle-scale farmers' parcels in the project area suggested that the industrial plantation A/R CDM would be more efficient than smallholders' plantation. The reduction of transaction cost was proved difficult because the DOE cost had little possibility to reduce, and the cost increase caused by demerit derived from plenty of farmers and parcels was inevitable. A part of labor cost and local material cost for forestation was reduced by establishing BPP. Eventually, since the cost of an A/R CDM project involving SSFs in Paraguay must be more than USD 31/ tCO_2, which far exceeded the realized CER price usually traded at USD 3–5/ tCO_2 before 2012, the A/R CDM project was financially unfeasible even in the best carbon market conditions. The CER price peaked in 2006 (Bryan et al. 2008), and declined sharply in 2012 before the first commitment period of the KP ended, and fallen to rock-bottom levels in 2013 (WB 2013a). In this situation, it was impossible to obtain carbon credit worth covering transaction cost, and additionality which was an essential requirement for CDM projects became meaningless.

For the third premise, sustainability of an A/R CDM project along with effectiveness of AF was examined. The A/R CDM project was not sustainable, because no carbon benefit was realized. On the contrary, the sustainability of forestation was found almost realized as shown in the results of evaluation conducted by MAG in 2010. The farmers' appreciation to the project would be brought by the project activity focused on awareness raising and BPP from 2004 to 2010. Forestation project without A/R CDM will give large impact to rural communities. Many farmers participated in AF in Paraguay. Farmers obtained benefit from AF by ensuring wood product without disturbing crop production at least 3-4 years after planting seedlings. The CER benefit from AF was smaller than from monoculture plantation because of low tree density in the parcels, which resulted in the deterioration of financial condition of the project promoter.

In short, an A/R CDM project was possible to acquire CER, however, no carbon benefit was realized, thus no sustainability was achieved. The hypothesis that a carbon benefit obtained from the A/R CDM involving smallholders could be used to improve the lives of smallholders was wrong.

The results of the study would be useful as a reference to the REDD+ or reducing emissions from deforestation and forest degradation in developing countries; and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries. If REDD+ aimed to obtain forestry carbon credit, there would occur the more serious problems than A/R CDM due to large uncertainty of carbon stocks change estimation, difficulties relating to implementation of safeguard activities, high management problem caused by largeness of project scale and participation of many organizations and people. This would lead to further collapse of carbon market price due to large supply of carbon credits. The fund flow for REDD+, of which USD 112.5 million was provided to UN-REDD Program (UN-REDD 2011), should be changed to use for implementing practical forest conservation or forestation projects in developing countries without expecting any carbon credits.

5.4 Conclusion and suggestion

From the results of analysis on the A/R CDM project in Paraguay, it was found that the A/R CDM project involving SSFs would not contribute to the improvement of livelihood of SSFs. The major cause was high transaction cost and low carbon benefit. The A/R CDM project involving

SSFs was judged as financially unfeasible. At present, potential to reduce transaction cost was only slight. No possibility of CER price rise was recognized in the carbon market suffered from oversupply. Negative aspects were remarkable; however, slightly positive aspects were observed in the A/R CDM projects. Table 5.1 summarized the main negative and positive aspects relating to an A/R CDM project.

As issues to be solved to realize an A/R CDN project, 5 issues were pointed out such as organizing SSFs, agreement of CER right with individual SSFs, confirmation of land right, procedures of DNA, and problems relating to forestation. Sufficient fund and time were required to solve all the issues. Since the project targeted plenty of SSFs, high loss rate of work done was found. For economic feasibility and reduction of transaction cost, high cost and low revenue was prominent. The high loss rate deteriorated further the economic unfeasibility. No sustainability of rural development applying the A/R CDM project was achieved, because no carbon benefit generated any return of carbon benefit to the participant communities.

Moreover, the A/R CDM project with economic loss could not acquire CER continuously; thus, the A/R CDM project was unsustainable. On the other hand, forestation itself was sustainable. The participant SSFs obtained benefit from forestation. Also SSFs acquired benefit from AF; however, the project promoter gained smaller carbon benefit from AF than from monoculture due to low density of planted trees in AF parcels. AF should not be introduced by an A/R CDM project, but by a simple forestation project.

If A/R CDM projects involving smallholders are to be implemented in the future with lucks of CER price rise, the experiences relating to formulation, implementation, and monitoring of an A/R CDM project which were achieved by the project in Paraguay, could serve as reference.

First, for formulation of A/R CDM project involving smallholders, the followings were found:

(1) The area where extensive needs for forestation by smallholders exist should be selected based on the information collected from local offices of related ministry or local governments;

(2) Awareness raising of farmers to improve their livelihood by themselves using the plan they made was important to ensure voluntary participation and to build ownership in the project;

(3) Introduction of AF and silvopastoral system were recommended in order to maintain agricultural or livestock production and reduce leakage of forestation, while carbon stocks increase was far lower than monoculture plantation. Periodic thinning according to canopy level should be conducted to ensure the yield of crop production. Introduction of cash crop trees like fruit trees would be profitable to farmers;

(4) The support for the material which farmers could not obtain by themselves should be limited to a part of the material cost based on BPP;

(5) The waste rate of time and expense such as in Paraguay should be taken into consideration. The appropriate number of farmers with middle-scale holdings should be co-opted to participate in A/R CDM projects to ensure a sufficient amount of CER in low

income rural area;

(6) A demonstration farm, which should be established at the place well accessible from every part of the project area, was effective to display various farming and AF techniques to participant farmers.

Second, for implementation of A/R CDM project, the followings were found:

(1) Support to smallholders for forestation should be at minimum on BPP, including technical assistance and provision of seedlings. Smallholders should provide their own resources (labor, land, local materials) with responsibility to ensure ownership of the forestation activity.
(2) A large difference in the growth of trees on forested parcels would happen several years later after providing seedlings. The difference was caused by natural disasters and basic land management such as drought damage, damage by leaf cutting ants, timing of plantation, management of seedlings, no- or less-weeding and so forth. It was necessary for project promoter to provide training and sufficient information on forest management to participant farmers.
(3) Management of forested parcels during the first year of plantation was so critical that weeding or pest control should be conducted appropriately. For degraded land, green manure intercropped with trees was recommended for ensuring tree growth.

Third, for monitoring and use of CER from A/R CDM project, the followings were found:

(1) If large number of sample plots were required due to high difference of tree growth between forested parcels in order to ensure precision level, establishing permanent sample plots with fixed number of trees e.g. 20 would be more efficient than with fixed size e.g. 400 m^2.
(2) Monitoring activities by local staff trained by OJT during the project was the most efficient way to ensure precision level of monitoring described in the methodology.
(3) Micro credit was considered as a way to use the funds from carbon credit efficiently for the purpose of rural development. However, after several trials, it was found difficult to manage the fund properly without long-term OJT, because micro credit required leadership of a responsible person and expertise of accounting within the farmers' group.

The WB suggested that the A/R CDM rules and procedures needed to be simplified for four key reasons: "(1) the AR sector strongly supports the sustainable development of impoverished rural areas; (2) the rules are excessively complex relative to those for projects in other sectors; (3) it is necessary to recognize that the capacity of poor rural peoples (to whom these projects are geared) is usually limited; and (4) projects in low income countries with great potential for carbon sequestration and subsequent poverty alleviation face fundamental challenges to success in the

CDM" (WB 2011b). If the current mechanism remains as it stands, there is little possibility that the A/R CDM projects involving smallholders could be promoted.

A large number of poor people in the world live in rural areas, which are vulnerable to the impacts of climate change, therefore, the support of rural people by implementing mitigation activity in rural area focusing on rural development is essential (FAO 2012b). In particular, forestation is vital for rural people because "forests, forestry and forest products are uniquely positioned to complement other agricultural activities in contributing to a sustainable future" (ibid.).

According to the statistics of FAO, the annually deforested area of LACs countries was highest in the world (ibid.), and Paraguay was no exception. The composition of LAC's flow of GHG was dominated by CO_2 emissions from land use change, which constituted 46 % of LAC's emissions, versus 17 % for the world (de la Torre et al. 2009). The leading cause of deforestation in LACs was "conversion of forests to grazing and cropland" (FAO 2012b). In residential areas of smallholders where the people converted forest to arable land and continued agriculture in the manner of exploitation for a long time, there were plenty of farmers who wished forestation to recuperate wood resources and soil fertility in the degraded land from the example of Paraguay.

Shames et al. stated that "even if the smallholder carbon market project model did not succeed in its current form, lessons from these experiences would be critical to the development of other mechanisms to support smallholder climate-smart agriculture such as Nationally Appropriate Mitigation Actions (NAMAs), integrated adaptation and mitigation funding programs and eco-certification schemes" (Shames et al. 2013). In order to contribute to sustainable development and mitigation of global warming, a new emission reduction mechanism which is economically rational should be established through resolving issues referring to the lessons learned from the experiences of A/R CDM projects involving smallholders (or SSFs) as in Paraguay.

Taking into account the present situation of the carbon market, a small-scale A/R CDM project should be warned to apply carefully in order that developing countries do not wrongly have excessive expectations for this methodology, unless a fundamentally new mechanism, e.g. allowing the use of ODA and public funds in projects, is introduced.

Forestation and AF are simple methods to sequestrate GHG, and are expected to ensure co-benefits in rural areas of developing countries where the potential area to be forested is widely distributed. Therefore, forestation projects for smallholders should be promoted, without applying A/R CDM mechanism. If forestation is implemented in the areas with high needs of forestation and based on BPP, incentive to farmers will be limited to technical guidance and supply of seedlings, because project promoter could mobilize farmers to provide their own resources (labor, land and local materials).

Table 5.1. Summary of main positive and negative aspects found in the A/R CDM project involving small-scale farmers in Paraguay

Item	Positive aspects	Negative aspects
Solving issues to realize an A/R CDM project		
Organizing SSFs	• Participatory approach was effective if awareness raising activity was conducted first. • Preparing a farm plan by SSFs was effective to establish SSFs' ownership of a project. • BPP was established through implementing MIG activity.	• High cost to organize a large number of SSFs to satisfy a threshold size of an A/R CDM project (300 ha) • More than 2 years were necessary for establishing BPP.
Agreement of CER right with SSFs	• The sharing of benefit (CER for the project promoter and forest benefit for SSFs) and cost (seedling for the project promoter and labor/materials for SSFs) was agreed.	• High cost to make an agreement with many SSFs individually. • High cancelation rate caused by low growth of forest found in pre-monitoring.
Land right	• As a way to simplify, clarification of land right was substituted with certificate of land occupation. • Shorter period to acquire certificate than formal land right.	• High cost and long time to obtain certificate of land occupation from INDERT for many SSFs individually, due to frequent change of SSFs' information. • High cancelation rate caused by low growth of forest found in pre-monitoring.
DNA	• The DNA could apply the experiences of the project to other areas.	• Long time was spent to obtain letter of approval (1.5 years) and declaration of low income communities (1.5 years). • Also it took a long time to decide forest definition (1.5 years).
Implementation of the project	• Most of SSFs planted seedlings provided by the project even if planted only a part of planned area.	• Characteristics of SSFs like changeable intention, tendency not to keep an agreed plan, and neglect of forest management caused delay, low quality of forestation, and increase of monitoring cost. • High cancelation rate caused by low growth of forest found in pre-monitoring. • Project period from formulation of the project to acquisition of first CER took 7.5 years, too long to obtain benefit from investment.
Economic feasibility of an A/R CDM project and reduction of the transaction cost		
Cost	• BPP decreased forestation cost because beneficiary SSFs provided their own labor and local materials. • Collaboration with public institutes and university reduced cost for organization of SSFs and scientific studies. • Local experts developed by OJT of the project could contribute to cost reduction by substituting with external experts in a subsequent project.	• The waste rate of activity was 70-80 % till acquiring CER. • High transaction cost of a project involving SSFs due to smallness of forested parcels, large number of participant SSFs dispersing widely in the project area, and characteristics of SSFs disturbing smooth implementation. • DOE cost was almost fixed, difficult to reduce..
Benefit	• Intangible benefit of forest (contribution to climate change mitigation) was valued. • If over middle-scale farmers were involved, efficiency of the project would be enhanced.	• Low unit price of forestry CER caused by no-permanence. • Uncertainty of the international carbon market. • No perspective of recovering CER value from the collapse in 2012.

Table 5.1. (Continued)

Item	Positive aspects	Negative aspects
Funding	· Since forestation was popular in Annex I countries, forestation project in non-Annex I countries had high possibility of obtaining support or funding from donor countries.	· Private sector had few interest in the projects generating little carbon benefit. · Use of ODA was prohibited in the CDM rule even if Annex I countries wished to support. · The funds of international development financing institutes for forestation was limited or stopped.
Contribution to sustainable development		
Forestation activity	· Forestation itself was sustainable because SSFs were satisfied with forestation and they expressed continuity of forestation. · SSFs recognized they could disseminate experiences and achievements learned from the project to others.	· The project promoter would stop activity if there's no carbon benefit. · Risk to stop an A/R CDM project was high due to 5 year interval of monitoring, uncertainty to obtain CER, change of SSFs' opinions, and generation change. · Long time around 5 years was necessary for capacity building to find the confidence of SSFs on their achievement.
Development in the project area	· Community activities of soil conservation contests, MIG, and MIC were effective. · Indirect benefit of biomass increase and improvement of environment was brought by a forestation project.	· Forestation in communal lands was not conducted due to lack of benefit sharing rule. · Rural development fund planned to be used for MIC or various communal activities was not established due to no carbon benefit.
Effectiveness of agroforestry		
Beneficiary farmers	· SSFs obtained additional benefit from forestation without disturbing crop production. · Other direct benefits except timber were expected like fruits, honey, and non-forest products if appropriate tree species were selected. · Indirect effect of windbreak and frost prevention could be expected. · High possibility to introduce silvopastral system to middle- or large-scale farmers by providing forest product and protection of cattle from strong radiation.	· No negative aspects for SSFs were found.
Project promoter	· Better forest management of SSFs and high growth of forest were expected in agroforestry than in monoculture forest. · Leakage could be set as zero due to no displacement of existing activities.	· Few carbon benefits from agroforestry due to low tree planting density.

Acknowledgments

I express thanks for guidance and assistance as well as for comments and suggestions of reviewers: Misa Masuda, Kunihiko Yoshino, Satoshi Tachibana, and Takeshi Mizunoya.

This paper was prepared on the successful acquisition of forestry CER from the A/R CDM project in Paraguay. I extend my gratitude to the following JIRCAS staff members for their contributions to the achievements of the project: Kunihiro Doi, Mamoru Watanabe, Shutaro Shiraki, Kenichiro Kimura, Hiroshi Ikeura, and Shinji Hirouchi.

I would also like to thank the following members of the staffs of the JIRCAS project in Paraguay: Tomio Hanano, Jorge Ogasawara, Justo López, Elvio Morínigo, and Roberto López. Their work was critical to the success of the A/R CDM project and is gratefully acknowledged.

Annex

Annex 1. Basic data relating to rural poverty and emission from LULUCF sector in the South American countries

Country	GDP per capita (USD 2000)	Agricultural value added (% GDP)	Rural as % of total population	Percentage of people living under USD 1.25/ day (% of total population)	Percentage of people living under USD 2/ day (%)	Arable land per head of agricultural population (ha/ cap)	Average annual deforestation (%)	Percentage of LULUCF in total GHG emission (%)[a]	Number of registered CDM projects
Source	IFAD 2010	IFAD 2010	IFAD 2010	IFAD 2010	IFAD 2010	IFAD 2010	WB 2013b	UNFCCC 2005e	UNFCCC 2013a
Period	Closest 2008	Closest 2008	Closest 2008	Closest 2008	Closest 2008	Closest 2007	2000-2010	1994 (1990 for Ecuador)	Registered by 31 December 2012
Argentina	9,915	9.4	8	4.5	11.3	10.1	0.81	-13.0	30
Bolivia	1,174	13.6	34	19.6	30.3	0.9	0.50	129.8	4
Brazil	4,448	6.7	14	5.2	12.7	2.6	0.50	124.1	227
Chile	6,229	4.2	12	2.0	2.4	0.6	-0.25	-49.6	62
Colombia	3,018	8.8	26	16.0	27.9	0.3	0.17	10.6	44
Ecuador	1,746	7.0	34	4.7	12.8	0.4	1.81	47.4	27
Guyana	950	31.0	72	-	-	3.5	0.00	-978.8	1
Paraguay	1,518	22.9	40	6.4	14.2	2.3	0.97	13.9	2
Peru	2,923	6.6	29	7.9	18.5	0.5	0.18	71.6	38
Suriname	2,662	5.2	25	-	-	0.7	0.01	-	-
Uruguay	8,788	10.8	8	2.0	4.2	3.9	-2.14	-2.9	22
Venezuela	5,963	4.0	7	3.5	10.2	1.4	0.60	-	-

Source) Author compiled from IFAD 2010, WB 2013b, UNFCCC 2005e, and UNFCCC 2013a.
[a] Negative number indicates that removal of GHG in LULUCF was larger than emission from LULUCF.

Annex 2. Registered A/R CDM projects introducing agroforestry

	Project title	Planting area (ha)	Area of AF[a] (ha)	Area of SP[b] (ha)	Contents of AF
1	Carbon sequestration through reforestation in the Bolivian tropics by smallholders of FECAR (Bolivia)	317	-	70	1) Species for SP: Pacay (*Inga sp.*), Tajibo (*Tabebuia sp.*), Paquio (*Hyminea courbaril*), Chilijchi (*Erithrina sp.*). 2) A rotation system for grazing will be introduced which avoids over- and under grazing. 3) Increase the grazing capacity of the land to 2.5 cows/ha/year from current 1.7 cows/ha/year. 4) Planting space: 3m×3m, or 3m×4m.
2	Reforestation of croplands and grasslands in low income communities of Paraguarí Department, Paraguay (Paraguay)	215	52	-	1) Plan of AF 52.35ha with *Grevillea robusta*. 2) Planting space: 5m×4m.
3	Forestry project for the basin of the Chinchiná river, an environmental and productive alternative for the City and the Region (Colombia)	4,539	619	3,920	1) AF model is established in existing coffee plantations with *Cordia alliodora* and *Pius tecunumanii*. 2) Planting space: 4m×4m, finally 204 trees/ha.
4	Ibi Batéké degraded savannah afforestation project for fuelwood production (Democratic Republic of Congo)	4,130	3,472	-	1) Acacia AF aims for cassava and charcoal production. Harvesting of acacia is 5～21 year cycle. Acacia regenerates naturally. Planting density is 1,100 trees/ha. 2) Cassava grows during 18 months before canopy closure becomes a limiting factor. 3) *Eucalyptus* and Pine AF is on 18 year rotation. Local species is harvested at 30 years after planting. 4) Weeding is a part of cassava cultivation. No need of weeding after 18 months. 5) Planting space except acacia: 3.33mx3.33m and 3m×3m.
5	Bagepalli CDM reforestation programme (India)	8,933	7,656	-	1)Main species (fruit trees) : *Mangifera indica*, *Anacardium occidentale*, and *Tamarindus indica*. 2) Other species: *Annona squamosa, Azadirachta indica, Ceiba pentandra, Leuceana leucocephala, Pongamia pinnata, Syzygium cummini* and *Zizypus jujube* depending on soil and water conditions, and personal preferences. 3) Planting space: fruit trees = 6m×6m, planting density with other species = 521 trees/ha, for tamarind 296 trees/ha.
6	Reforestation of degraded/degrading land in the Caribbean savannah of Colombia (Colombia)	2,195	1,502	492	1) Three kinds of AF: (1) Establishment of 492.4 ha of trees and shrubs on moderately degraded lands, (2) reforestation of 1,502.2 ha with *Hevea brasiliensis* by smallholders, (3) reforestation of 200.2 ha with *Tabebuia rosea, Cariniana pyriformis*, and *Tectona grandis* by medium farmers. 2) Activity1: timber and fruit tree = 5m×5m spacing, finally 100 trees/ha. 3) Activity2: Spacing = 3m x 2.8m. 4) Activity 3: Spacing = 3m x 3m.
7	Carbon sequestration in small and medium farms in the Brunca Region, Costa Rica (Costa Rica)	892	227	160	1) The species selection is based on site conditions and farmer's preferences. The average planting density is 400 trees/ha, with a tree crown cover above 30 % at maturity in situ. 2) 2 major systems: one for intercropping with cash crops, the other for silvopastoral systems.

Annex 2. (Continued)

	Project title	Planting area (ha)	Area of AF[a] (ha)	Area of SP[b] (ha)	Contents of AF
8	Agro-forestry interventions in Koraput District of Orissa (India)	380	380	-	1) Harvesting of tree is scheduled for 4th, 8th, 12th and 16th year and then in the 20th, 24th, 28th and 32nd year. Subsequent to the 4th harvest, fresh plantations will be established (2,200 trees/ha). 2) AF of *Eucalyptus* plantations inter-cropping of pulses, vegetables and fodder crops.

Source) The author compiled from UNFCCC data (UNFCCC 2013a).
[a, b] AF: Agroforestry, SP: Silvopasture

Annex 3. Number of farm households and area of agricultural land in the Department of Paraguarí

Stratum	Farm households		Agricultural land	
	Country (households)	Paraguarí (households)	Country (ha)	Paraguarí (ha)
No land	774	18	-	-
Less than 1ha	15,586	1,979	6,894	954
1-5ha	101,643	12,712	231,118	27,620
5-10ha	66,218	4,067	416,702	25,991
10-20ha	57,735	2,659	685,381	33,568
20-50ha	22,865	1,277	619,986	35,815
50-100ha	6,879	385	459,555	25,030
100-200ha	5,234	220	699,257	28,975
200-500ha	5,251	220	1,600,537	65,312
500-1,000ha	2,737	127	1,810,119	85,151
1,000-5,000ha	3,443	132	7,200,531	250,818
5,000-10,000ha	684	11	4,702,034	79,143
More than 10,000ha	600	2	12,654,779	25,900
Total	289,649	23,809	31,086,893	684,277
Total of less than 20ha	241,956	21,435	1,340,095	88,133
Percentage of less than 20ha	83.53	90.03	4.31	12.88

Source) MAG 2008.

Annex 4. Examination of candidate tree species

Source	Tree species	Local name	Characteristics	Observation
Preference of farmer	*Cordia trichotoma*	Peterevy	Suitable for AF. Used as a building material. Native species.	Slow growth, more than 20 years required for harvesting.
	Parapiptadenia rigida	Kurupayra	Used for post, firewood, charcoal, building material. Native species.	Slow growth.
	Cedrela fisilis	Cedro	Better to grow in natural forest. Suitable for furniture. Native species.	Without pruning, unsuitable for furniture material.
	Melia azedarach	Paraiso gigante	Suitable for AF. Fast growth, harvested in about 10 years. Used for furniture, pillar. Exotic species.	Disease reported.
	Leucaena leucosephala	Leucaena	Branches and leaves used for organic fertilizer, fodder. Trunk and branches used for firewood. Native species.	Slow growth. Unsuitable for wood.
	Eucalyptus	*Eucalyptus*	Withstand drying, seasonal flooding, saline soils. Durable hard wood. Used post, furniture, decoration material. Exotic species.	
	Citrus aurantifolia	Citricos	Fruit tree. Exotic species.	Height is 3m or less, not regarded as defined trees.
INFONA	*Peltophorum dubium*	Ybyra pyta	Common in Paraguay. Used for construction, plate material. Native species.	Very common. Not regarded as planting tree by farmers.
	Phithecolobium saman	Manduvira	Branches and leaves used for fodder, trunk used for furniture, interior materials. Native species.	Easily deprived of moisture and nutrients by epiphytes.
	Albizia hassleri	Ybra-ju	Stem grows straight. Suitable for AF. Native species.	Slow growth compared to the exotic species.
	Manguifera indica	Mango	Fruit tree. Used for building material and furniture. Exotic species.	Marketing the fruits is difficult, due to large amount of the fruits commercialized seasonally in Paraguay.
	Azadirachta indica	Neem	Used for post. Strong in dry climate. Insect repellent. Exotic species.	Unable to be used for timber. Necessary to check the resistance of diseases.
	Inga spp.	Inga	Suitable for timber, firewood, post, fodder. Native species.	Height is around 10m.
	Toona ciliata	Toona	Suitable for furniture. Native species.	Stem becomes abnormally large by disease.
JICA report[a]	*Eucalyptus grandis*	*Eucalyptus grandis*	Fast growth, strong and durable moderately. Used for light structural lumber and pulp.	Unsuitable for wet land.
	Eucalyptus camaldulensis	*Eucalyptus camaldulensis*	Growth slightly lower than *E.grandis*. Able to withstand dryness, high groundwater level, swamp. Used for furniture, post, decoration materials.	Regarded as 80 % growth of *E.grandis*.
	Melia azedarach	Paraiso gigante	Above-mentioned.	Above-mentioned.
	Pinus taeda	Taeda	Used for lumber. Resistant to blight.	Not well-suited to AF. Timber volume at harvest is great. Take 25 years to harvest.
	Pinus elliottii	Elliotti	Used for lumber and pulpwood. Pine tar collected.	Not well-suited to AF. Take 25 years to harvest.

Source) Yokokura et al. 2007 and ([a]) JICA 2002

Annex 5. Reasons for cancellation

Community	Code of parcel	Reason for cancellation
Carrera	RC3-1, 3-2	Unable to plant due to advanced age.
	RC7-1	Having had surgery for prostate cancer, now resting.
	RC8-1	Mental instability, unable to work.
	RC15-1, 15-2	Planted, but short of 0.5ha.
Rincon Sur	RRS1-1, 1-2	Loss in the drought. No time to replant, because hired for a large farm.
	RRS5-1	Damaged by drought, lost interest in forestation.
	RRS6-1	Unable to plant due to illness and advanced age.
	RRS13-1	Damaged by drought.
	RRS15-1	No planting more than 50 %.
	RRS16-1	No planting more than 50 %.
	RRS19-1, 19-2	Sold the parcel to new owner who had no interest in forestation.
	RRS22-1	Planted area about 0.2ha.
Rincon Costa	RRC6-1	Work in Asunción without planting.
Moquete	RM3-1	Planting in other land where the area was less than 0.5ha.
	RM8-1, 8-2	Husband left to work in other region without planting.
	RM18-1	Damaged by drought.
Aguaiy'mi	RA4-1	Planted around the house, left for Buenos Aires as a migrant worker.
	RA6-1	Planted in different land, where area was less than 0.5ha.
Mbocayaty	RMb1-1, 1-2	Planted, but damaged by drought.
Cabello	Aca8-1, 8-2	Planted 2 times in the same parcel, but damaged by drought every time.
Maria Auxiliadora	AMA10-2	Planted but damaged by drought. Put cattle into the parcel, now used for grazing.
San Juan	ASJ2-1, 2-2	Lost motivation for forestation.
	ASJ9-1, 9-2	Planted, but damaged by drought, no intention of replanting.
	ASJ11-1	Community land, and none of community members having responsibility for no planting.
Itakyty	AI10-1	Without planting, gone to Spain as a migrant worker.
3 de Febrero	A3F3-1	Planted, but damaged. Having intention to replant, yet not implemented.
Lagna Pyta	ALP2-1, 2-2	Planted, but less than 0.5ha. No motivation to plant remaining area.
	ALP9-1, 9-2	Planted, but less than 0.5ha.
	ALP12-1	Planted in a different land.
Yukyty	AY2-1, 2-2	Not finished planting.
	AY5-1	Without planting, no willingness of planting in the future.
Tape Guazu	ATG2-1, 2-2	Planted in different land.
	ATG3-1, 3-2	Planted in different land.
Other communities	AOC1-1	No planting due to health problems.
	AOC7-2	Without planting *Grevillea robusta*, changed mind to plant *E.grandis*.
	AOC8-2	Planted one of several small parcels as planned.
	AOC12-1	Planted, but damaged by drought. Lost interest in forestation.
	AOC13-1	Planted, but damaged by fire. Lost interest in forestation.
	AOC15-1	No planting due to illness and advanced age.
	AOC16-1	Planted, but damaged by drought.
	AOC19-1	Planted 50 % of the parcel. Gone to other region for working.

Source) Matsubara et al. 2011

Annex 6. Agroforestry practices in Caazapá and San Pedro in 2011

Department	Area of AF (ha)	Tree species	Spacing	Tree age (year)	Cultivated crops
Caazapá		Ybyra pyta, Paraiso gigante, Toona, Citrus (Valencia)	7 m×5 m	5	Cassava, maize
Caazapá	1 ha	Toona, Citrus	6 m×5 m	7	Poroto beans
Caazapá	1 ha	Yvyrá pytá, Paraíso gigante, Kurupay, *Eucalyptus grandis*, Citrus	Citrus: 6 m×5 m	6	Ground nuts
Caazapá	AF:1 ha AFF:1 ha	AF: Cedro, Timbo, Guayaivi, Yvyra pyta, Lapacho, Kurupay kuru, Yvyraro, Paraiso gigante, etc. AFF: Tree species and Citrus	AF: 7 m×7 m AFF:7 m×5 m	6	AF: cassava, maize, poroto beans, ground nuts AFF: cassava, poroto beans, ground nuts
Caazapá	AFF:0.5 ha	*Hovenia dulcis*, Yvyra pyta, Paraiso gigante, Citrus	7 m×4 m	-	Cassava, sesame
San Pedro	AF:2 ha	Toona,Ybvra pyta, Lapacho, Paraiso gigante	6 m×2 m	16	Poroto beans, maize, ground nuts, cassava, sesame
San Pedro	Forestry: 4.75 ha	Lapacho, Guatambu,Urundey mi, Toona, Paraiso gigante, Hovenia	6 m×2 m, 6 m×4 m	15	Cotton, sesame, poroto beans, maize (green manure: mucuna, pigeon pea, oats, lupine)
San Pedro		Toona, Yvyra pyta, Cedro, Peterevy, Lapacho, Guayaivi, etc.	6 m×4 m	5	Cassava, pumpkin, poroto beans

Source) Matsubara et al. 2012

References

Angelsen, Wunder S. 2003. “Exploring the forest - poverty link: key concepts, issues and research implications.” CIFOR Occasional Paper No. 40.

Basu. 2009. “A green investment.” *Nature* Vol. 457: 144-146.

BCF. 2013. https://wbcarbonfinance.org/. Accessed September 10, 2013.

Blaser, Robledo C. 2007. “Initial analysis on the mitigation potential in the forestry sector.” A report prepared for UNFCCC Secretariat. Intercooperation. Bern.

Bolivia. 2012. “Non-market approaches in the context of policy approaches and positive incentives on issues relating to reducing emissions from deforestation and forest degradation in developing countries; and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries.” Presented to the UNFCCC, December 2012. Plurinational State of Bolivia.

Boyd, Gutierrez M., and Chang M. 2005. “Adapting small-scale CDM sinks projects to low-income communities.” Tyndall Centre for Climate Change Research Working Paper 71.

Brodnig. 2009. “Sharing benefits from carbon finance: lessons from the Guangxi CDM project.” The World Bank.

Brown, Dettmann P., Rinaudo T., Tefera H., and Tofu A. 2011. “Poverty alleviation and environmental restoration using the Clean Development Mechanism: a case study from Humbo, Ethiopia.” *Environmental Management* Vol. 48(2): 322-333.

Bryan. Akpalu W., Yesuf M., and Ringler C. 2008. “Global carbon markets; are there opportunities for Sub-Saharan Africa?” International Food Policy Research Institute (IFPRI) Discussion Paper 00832.

Cacho, Marshall G. R., and Milne M. 2003. “Smallholder agroforestry projects: potential for carbon sequestration and poverty alleviation.” ESA Working Paper No. 03-06. FAO.

Chomitz, K. M., Buys P., De Luca G., Thomas T. S., and Wertz-Kanounnikoff S. 2006. “At loggerheads? Agricultural expansion, poverty reduction, and environment in the tropical forests.” World Bank Policy Research Report.

Curnow, Hodes G. 2009. “Implementing CDM projects guidebook to host country legal issues.” UNEP Risoe Centre.

de la Torre, Fajnzylber P., and Nash J. 2009. “Low carbon, high growth: Latin American responses to climate change: an overview.” The World Bank.

Derwisch, Schwendenmann L., Olschewski R., and Hölscher D. 2009. “Estimation and economic evaluation of aboveground carbon storage of *Tectona grandis* plantations in western Panama.” *New Forests* Vol. 37:227-240.

DGEEC. 2004a. “Paraguay pobreza y desigualdad de ingresos a nivel distrital.” Dirección General de Estadística, Encuestas y Censos. Paraguay.

DGEEC. 2004b. “Resultados finales censo nacional de población y viviendas. año 2002.” Dirección General de Estadística, Encuestas y Censos. Paraguay.

FAO. 2010. “Global forest resources assessment 2010 – main report.” FAO Forestry Paper No. 163.

FAO. 2011. FAOSTAT. FAO Statistics Division.

FAO. 2012a. “Forest and climate change working paper 11 – forest management and climate change: stakeholder perceptions.” FAO.

FAO. 2012b. “State of the world’s forests 2012”. FAO.

FAO. 2012c. “Global forest land-use change 1990–2005.” FAO Forestry Paper 169.

FFPRI. 2006. “Roadmap (miti an-nai kaisetsu sho) sinki shokurin/ sai shokurin clean kaihatsu mechanism dai 1.0 ban.” [Roadmap (guidance) for afforestation/ reforestation Clean Development Mechanism, first edition]. Forestry and Forest Products Research Institute. Japan.

Fois, Paredes P., and Vega S. 2004. “Nivel de fertilidad de la camada superficial de los suelos de la región oriental del Paraguay.” Primer Seminario Intercambio de Experiencias en Manejo y Conservación de Suelos en el Paraguay. Estudio de Validación del Desarrollo Rural Participativo Basado en la Conservación del Suelo. J-Green.

Fukushima. 2012. “The significance of CSR in A/R CDM promotion from the case study of Japan: a focus on corporate forest-related activities and emission trading.” *Journal of Forest Research* May 2012: 1-12.

Gardi, Robledo C., Shimizu T., Rattinger M., and Rivera G. 2010. “Climate change: agriculture, forestry, and other land-use (AFOLU) for addressing climate change mitigation and adaptation in the Latin American and Caribbean region.” Inter-American Development Bank (IDB) Technical Notes No. IDB-TN-135.

Gera, Chauhan S. 2010. “Opportunities for carbon sequestration benefits from growing trees of medicinal importance on farm lands of Haryana.” *The Indian Forester* March 2010: 287-300.

Gera, Gera M., and Bisht N. S. 2011. “Carbon sequestration potential of selected plantation interventions in Terai region of Uttarakhand.” *The Indian Forester* March 2011: 273-289.

Gittinger. 1982. *Economic analysis of agricultural projects.* EDI Series in Economic Development. The Johns Hopkins University Press.

Godoy, Rivas V., Miranda L., Acosta Z., Funes L., and Olmedo T. 2010. “Estudio de validación de medidas contra el calentamiento global basado en AR-CDM en el Paraguay - PROYECTO JIRCAS Informe de Evaluación.” Ministro de Agricultura y Ganadería, Paraguay.

IFAD. 2009. “Smallholder farming in transforming economies of Asia and the Pacific: challenges and opportunities.” Discussion Paper prepared for the side event organized during the thirty-third session of IFAD’s Governing Council.

IFAD. 2010. “The rural poverty report 2011.” The International Fund for Agricultural Development.

IPCC. 2003. “Good practice guidance for land use, land-use change and forestry.” Intergovernmental Panel on Climate Change.

IPCC. 2008. “Climate change 2007 - synthesis report.” Intergovernmental Panel on Climate Change.

IPCC. 2013. “Working group I contribution to the IPCC fifth assessment report climate change 2013: the physical science basis summary for policymakers.” Intergovernmental Panel on Climate Change.

J-Green. 2007a. “Guía 1, fase 1: Cimentación de un fundamento para un desarrollo rural sostenible, proyecto J-Green 2007.” Agencia de Recursos Verdes del Japón.

J-Green. 2007b. “Guía 2, fase 2: Planificación y ejecución sostenible en base al manejo integral de los recursos naturales, proyecto J-Green 2007.” Agencia de Recursos Verdes del Japón.

JICA. 2002. “Estudio sobre el plan de reforestación en la region oriental de la República del Paraguay.” Japan International Cooperation Agency.

Jindal, Swallow B., and Kerr J. 2008. “Forestry-based carbon sequestration projects in Africa: potential benefits and challenges.” *Natural Resources Forum* 32: 116-130.

JREI. 2009. “J-VER seido ni taisuru jititai oyobi kigyou no isiki chousa kekka.” [Survey results of the local governments and private companies for the J-VER system]. Japan Real Estate Institute.

Kankyo-shou. 2012. “Heisei 23 nen do carbon offset report.” [Carbon offset report 2011]. Ministry of the Environment. Japan.

Lasco, Abasolo E. and Villamor G. 2010. “Payments for carbon sequestration in the Philippines: lessons and implications.” *Mountain Forum Bulletin* January 2010: 55-57.

Li, Zhang Y., Wang X., Li Y., and Zhao W. 2012. “An optimization model of carbon sinks in CDM forestry projects based on interval linear programming." *Energies* Vol. 5(6): 1766-1781.

Locatelli, Pedroni L. 2003. "Rewarding carbon sequestration in forest plantation projects: how the CDM could be attractive to small stakeholders?" Working Paper. Global Change Group. CATIE. January 2003.

Locatelli, Pedroni L. 2004. "Accounting methods for carbon credits: impacts on the minimum area of forestry projects under the Clean Development Mechanism." *Climate Policy* Vol. 4(2): 193-204.

Locatelli, Pedroni L. 2006. "Will simplified modalities and procedures make more small-scale forestry projects viable under the Clean Development Mechanism?" *Mitigation and Adaptation Strategies for Global Change* Vol. 11(3): 621-643.

Locatelli, Pedroni L., and Salinas Z. 2008. "Design issues in Clean Development Mechanism forestry projects." *Climate Change and Forests: Emerging Policy and Market Opportunities*. Brookings Institution Press. 107-121.

MAG. 2008. "Censo agropecuario nacional 2008." El Ministerio de Agricultura y Ganadería. Paraguay.

Malmsheimer, Bowyer J. L., Fried J. S., Gee E., Izlar R. L., Miner R. A., Munn I. A., Oneil E., and Stewart W.C. 2011. "Managing forests because carbon matters: integrating energy, products, and land management policy." *Journal of Forest* Vol. 109: S7-S50.

Maslin, Scott J. 2011. "Carbon trading needs a multi-level approach." *Nature* Vol. 475: 445-447.

Matsubara, Yokokura J., Kimura K., Saitoh T., Kobayashi T., and Saitoh M. 2008. "Shigen rikatuyoh gata tikyuu ondanka bohshi taisaku kentoh chosa houkoku sho – Paraguay and Viet Nam." [Report on the study on measures to prevent global warming by the use of local resources – Paraguay and Viet Nam]. J-Green.

Matsubara, Kimura K., and Izumi T. 2009. "Clean kaihatsu mechanism no sikumi wo katsuyoh sita nouson kaihatsu shuhou no kaihatsu houkoku sho - Paraguay and Viet Nam." [Report on the study for establishment of rural development method using Clean Development Mechanism - Paraguay and Viet Nam]. JIRCAS.

Matsubara, Kimura K., and Izumi T. 2010. "Clean kaihatsu mechanism no sikumi wo katsuyoh sita nouson kaihatsu shuhou no kaihatsu houkoku sho - Paraguay" [Report on the study for establishment of rural development method using Clean Development Mechanism - Paraguay]. JIRCAS.

Matsubara, Watanabe M., Ikeura H., and Hirouchi S. 2011. "Clean kaihatsu mechanism no sikumi wo katsuyoh sita nouson kaihatsu shuhou no kaihatsu houkoku sho - Paraguay." [Report on the study for establishment of rural development method using Clean Development Mechanism -

Paraguay]. JIRCAS.

Matsubara, Watanabe M. 2012. "Anettai ni okeru shokurin CDM wo katsuyou sita tei tanso gata nouson shakai no koutiku shuhou no kakuritu houkoku sho - Paraguay." [Report on the study for establishment of low-carbon rural society by using forestry CDM in subtropical regions - Paraguay]. JIRCAS.

Morera, ed. 2007. "Guidebook to markets and commercialization of forestry CDM projects." Centro Agronómico Tropical de Investigación y Enseñanza.

Nakakaawa, Aune J., and Vedeld P. 2010. "Changes in carbon stocks and tree diversity in agro-ecosystems in south western Uganda: what role for carbon sequestration payments?" *New Forest* Vol. 40:19-44.

OECD. 2004. "ODA eligibility issues for expenditures under the Clean Development Mechanism (CDM)." DAC/CHAIR(2004)4/FINAL. Development Assistance Committee. OECD.

Ohue, Yokokura J., Watanabe M., Sakamoto N., and Hanano T. 2007. "Nouchi dojoh shinshoku boshi taisaku jissho chosa houkoku sho - Paraguay (dai 3 nennji)." [Report on verification study for soil erosion prevention measures in farmland - Paraguay (third year)]. J-Green.

Palmer, Silber T. 2009. "Trade-offs between carbon sequestration and poverty alleviation: preliminary evidence from the N'Hambita community carbon project in Mozambique." Research Papers in Environmental and Spatial Analysis No. 130. The London School of Economics and Political Science.

Peskett, Luttrell C., and Brown D. 2006. "Making voluntary carbon markets work better for the poor: the case of forestry offsets." Overseas Development Institute.

Peskett, Brown J., and Schreckenberg K. 2010. "Carbon offsets for forestry and bioenergy: researching opportunities for poor rural communities." Overseas Development Institute.

Peters-Stanley, Hamilton K., Marcello T., and Sjardin M. 2011. "Back to the future: state of the voluntary carbon markets 2011." Ecosystem Marketplace & Bloomberg New Energy Finance.

Place, Ajayi O. C., Torquebiau E., Detlefsen G., Gauthier M., and Buttoud G. 2012. "Improved policies for facilitating the adoption of agroforestry." *Agroforestry for Biodiversity and Ecosystem Services: Science and Practice.*

Rennaud, Ruitenbeek J., and Tennigkeit T. 2012. "Challenges of community-forestry based carbon projects: process, participation, performance." *Field Actions Science Reports* Special Issue 7.

Salazar, Pinchansky S. C., co-ed. 2002. "Climate change and development case book - cases in Latin America related to the world market integration of atmospheric carbon reduction services and cleaner energy." Series: Environment and Development 2002. United Nations Development Programme (UNDP), the Central American Institute of Business Administration

(INCAE), and the Central American Commission for Environment and Development.

Shames, EcoAgriculture Partners. 2013. “How can small-scale farmers benefit from carbon markets?” CCAFS Policy Brief No.8. CGIAR Research Program on Climate Change, Agriculture and Food Security.

Skutsch. 2005. “Reducing carbon transaction costs in community based forest management.” *Climate Policy* Vol. 5(4): 433-443.

Schoene, Netto M. 2005. “The Kyoto protocol: what does it mean for forests and forestry?” *Unasylva* Vol. 56(222): 3-11.

Smith. 2002. “Afforestation and reforestation in the Clean Development Mechanism of the Kyoto protocol: implications for forests and forest people.” *International Journal of Global Environmental Issues* Vol. 2(3/4): 322-343.

Smith, Scherr S. J. 2002. “Forest carbon and local livelihoods: assessment of opportunities and policy recommendations.” CIFOR Occasional Paper No. 37.

Sonwa, Walker S., Nasi R., and Kanninen M. 2011. “Potential synergies of the main current forestry efforts and climate change mitigation in Central Africa.” *Sustainability Science* Vol. 6: 59-67.

Staddon. 2009. “Carbon financing and community forestry: a review of the questions, challenges and the case of Nepal.” *Journal of Forest and Livelihood* Vol. 8(1): 25-32.

Stern. 2006. *Stern Review: The economics of climate change*. Cambridge University Press.

UN. 1992. “United Nations framework convention on climate change.” United Nations.

UN. 1998. “Kyoto protocol to the United Nations framework convention on climate change.” United Nations.

UNFCCC. 2001a. “Decision 11/CP.7.” UNFCCC.

UNFCCC. 2001b. “Decision 17/CP.7.” UNFCCC.

UNFCCC. 2003. “Decision 13/CP.9.” UNFCCC.

UNFCCC 2005a. “Decision 3/CMP.1.” UNFCCC.

UNFCCC. 2005b. “Decision 5/CMP.1.” UNFCCC.

UNFCCC. 2005c. “Decision 6/CMP.1.” UNFCCC.

UNFCCC. 2005d. “Decision 16/CMP.1.” UNFCCC.

UNFCCC. 2005e. “Inventories of anthropogenic emissions by sources and removals by sinks of greenhouse gases.” FCCC/SBI/2005/18/Add.2. UNFCCC.

UNFCCC. 2006. "Facilitating reforestation for Guangxi watershed management in Pearl River basin" Reference number 547.

UNFCCC. 2007a. "EB 35 report annex 17." CDM - Executive Board. UNFCCC.

UNFCCC. 2007b. "EB 35 report annex 18." CDM - Executive Board. UNFCCC.

UNFCCC. 2007c. "AR-AMS0001 simplified baseline and monitoring methodologies for selected small-scale afforestation and reforestation project activities under the clean development mechanism version 04." EB 33 Annex 13.

UNFCCC. 2007d. "Combined tool to identify the baseline scenario and demonstrate additionality in A/R CDM project activities version 01." EB 35 report annex 19. CDM - Executive Board. UNFCCC.

UNFCCC. 2009a. "Project design document 'Reforestation of croplands and grasslands in low income communities of Paraguarí Department, Paraguay' version 3, 12 February 2009." Reference number 2694.

UNFCCC. 2009b. "Reforestation of severely degraded landmass in Khammam District of Andhra Pradesh, India under ITC social forestry project." Reference number 2241.

UNFCCC. 2009c. "Project design document 'Reforestation as renewable source of wood supplies for industrial use in Brazil' version 03a, 16 February 2009." Reference number 2569.

UNFCCC. 2010. "A/R methodological tool 'Calculation of the number of sample plots for measurements within A/R CDM project activities' version 02.1.0." EB 58 Report Annex 15.

UNFCCC. 2011a. "Project design document 'Ibi Batéké degraded savannah afforestation project for fuelwood production (Democratic Republic of Congo)' version PCI-B#1.1, December 1st, 2010." Reference number 4176.

UNFCCC. 2011b. "Project design document 'Bagepalli CDM reforestation programme' version 7, 1st April 2011." Reference number 4851.

UNFCCC. 2011c. "A/R methodological tool 'Demonstrating appropriateness of allometric equations for estimation of aboveground tree biomass in A/R CDM project activities' version 01.0.0." EB 65 Report Annex 28.

UNFCCC. 2012a. "Clean Development Mechanism project standard version 02.1." CDM - Executive Board UNFCCC.

UNFCCC. 2012b. "Humbo Ethiopia assisted natural regeneration project." Reference number 2712.

UNFCCC. 2012c. "Guidelines on accounting of specified types of changes in A/R-CDM project activities from the description in registered project design documents, version 02.0." EB 66

Report Annex 24.

UNFCCC. 2012d. “AR-TOOL14, A/R methodological tool ‘Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities’ version 03.0.0.” EB 70 Annex 35.

UNFCCC. 2012e. “Glossary CDM terms version 07.0.” CDM-EB07-A04-GLOS.

UNFCCC. 2013a. http://cdm.unfccc.int/Projects/projsearch.html. Accessed from December 25, 2012 to September 30, 2013.

UNFCCC. 2013b. http://cdm.unfccc.int/Statistics/Public/index.html. Accessed from December 25, 2012 to September 30, 2013.

UN-REDD. 2011. “The UN-REDD programme strategy 2011-2015.” The UN-REDD programme.

Vallejo, Reddy R. C., and van der Linden M. 2011. “Manual for monitoring of CDM afforestation and reforestation projects, part I - standard operational procedures version 1.” BioCF.

van Kooten. 2009. “Biological carbon sequestration and carbon trading re-visited.” *Climate Change* Vol. 95: 449-463.

Waterloo, Spiertz P. H., Diemont H., Emmer I., Aalders E., Wichink-Kruit R., and Kabat P. 2001. “Criteria, potentials and costs of forestry activities to sequester carbon within the framework of the Clean Development Mechanism.” Alterra.

WB. 2003. “Reaching the rural poor - a renewed strategy for rural development.” The World Bank.

WB. 2010. “World development report 2010.” The World Bank.

WB. 2011a. “World development indicators.” The World Bank.

WB. 2011b. “BioCarbon fund experience - insights from afforestation and reforestation Clean Development Mechanism projects.” World Bank Carbon Finance Unit.

WB. 2012. “State and trends of the carbon market 2012.” Carbon Finance at the World Bank.

WB. 2013a. “Mapping carbon pricing initiatives - developments and prospects 2013.” Carbon Finance at the World Bank.

WB. 2013b. “World development indicators.” The World Bank.

Wittman. 2012. “Climate-friendly agriculture and the Clean Development Mechanism- an assessment of future prospects for agriculture and land use change in Latin America.” Paper presented at the International Conference on Global Land Grabbing II, the Land Deals Politics Initiative (LDPI) and hosted by the Department of Development Sociology at Cornell University.

WMO. 2013. “The global climate 2001-2010: a decade of climate extremes.” World Meteorological Organization.

Yamanoshita, Amano M. 2012. “Capability development of local communities for project sustainability in afforestation/ reforestation Clean Development Mechanism.” *Mitigation and Adaptation Strategies for Global Change* Vol. 17: 425-440.

Yokokura, Ohue Y., and Hanano T. 2007. “Shigen rikatuyoh gata tikyuu ondanka bohshi taisaku kentoh chosa houkoku sho - Paraguay (dai 1 nenji).” [Report on the study on measures to prevent global warming by the use of local resources - Paraguay (first year)]. J-Green.